
Yanong
Mar.
1922

IX.

Remarks on the Mineralogy and Geology of Nova Scotia.

BY CHARLES T. JACKSON AND FRANCIS ALGER.*

Communicated to the Academy, August, 1831, by Thomas Nuttall, A. A. S.

THE peninsula of Nova Scotia is included between the 43d and 46th degrees of north latitude, and between the 61st and 67th degrees of longitude west of the meridian of Greenwich. It is

* In justice to our readers, it becomes us perhaps to state, that the paper now offered to the public through the American Academy's Memoirs, is, in part, a republication of an essay which originally appeared in Professor Silliman's American Journal of Science in 1828-9. It is that essay corrected and enlarged to a considerable extent, by the additional facts collected during a more recent, and, from the method adopted, we believe a more general and accurate examination of the Peninsula of Nova Scotia in the summer of 1829; undertaken with the view of determining the character of some few spots which had not been visited during our former excursion, or on which, from causes beyond our control, we were then unable to bestow that minute attention, to which their structure and interesting geological relations have since shown them so fully entitled. Some paragraphs in the former paper have been omitted in this, in a few places, where it became necessary from a more particular examination of the subjects to which they related; others have also been substituted in a few places, where the description of a substance would be made more brief, or where a still more interesting form of a substance could be brought in with advantage. This paper is intended to comprise, with as much order as the blending of old observations with new would admit, such

connected with the continent by a narrow isthmus, and is bounded on the north by the Strait of Northumberland, on the northeast by the Gut of Canseau, by which it is separated from Cape Breton, on the south and southeast by the Atlantic ocean, and on the west by the Bay of Fundy. The whole Province is nearly three hundred miles in length, by one hundred and fifty in breadth, and embraces not less than fifteen thousand square miles of surface.

The face of the country presents, with some irregularity, three distinct ranges of high land, two of which have some claim to the title they bear, of mountains, although they rarely attain an elevation of more than five hundred feet above the sea. The other range consists of rounded hills of inconsiderable elevation, extending through the county of Cumberland, and the districts of Colchester and Pictou. The first two ranges are called the South and North mountains; the former extending through the Province in the direction east-northeast, and crossing the counties of Annapolis, Kings, Hants, Colchester, and Pictou. This range is bounded, on the north and west, by the valley through which the

facts relating to the geological structure and mineral productions of Nova Scotia, as have come within the scope of our personal examination. We are aware that a large blank remains to be filled up on the subjects of which it treats, before these interesting branches of the natural history of that region can be fully elucidated or its real mineral resources made known; and we can only repeat, what we have said on a former occasion, that we hope soon to see it filled up by the examinations of our own countrymen, as well as of the inhabitants of Nova Scotia, to whom, more properly, the labor seems to belong. But we trust that enough will be said, to show that the country, in her mineral constitution, has treasures laid up, which will afford ample materials for the exercise of the native skill and industry of her citizens, and will always secure to her the advantages of an exporting trade.

Annapolis river winds its course for more than eighty miles, carrying with it the rich loam brought by the rivulets and torrents which contribute their waters to swell this beautiful river, depositing it along its course, and thereby forming a part of the fertile alluvium of this valley. The North mountains, however, contribute much more generously to the fertility of the land, from the peculiar rocks of which they consist, producing by their decay the most luxuriant soil. The North mountains form the southwestern coast of the Province, skirting the Bay of Fundy, and having the Annapolis river at their southern base. They extend, with but a single interruption in their continuity, nearly one hundred and thirty miles, and present to the sea an insuperable barrier against its encroachments. The direction of this range is northeast and southwest, with a gentle curve towards the Bay of Fundy, to which it presents a series of lofty mural precipices, well adapted to resist the encroachments of its overwhelming tides and tumultuous waves. This range formed by far the most fruitful field of our researches, and rewarded our labors by presenting the most interesting appearances, and many rare and beautiful specimens. We shall describe it nearly in the order in which its different parts were examined by us, beginning with Digby Neck, which affords peculiar facilities to the researches of inquirers into its geological structure and mineral productions.

This narrow strip of land is a continuation of the North mountains from Annapolis Gut, and, extending thirty miles to the westward, is bounded on the north by the Bay of Fundy, and on the south by St. Mary's Bay, which separates it from the main territory. At its western extremity are situated Long Island and Brier's Island; the former separated from the latter by Grand Passage, and from the main peninsula by Petit Passage; but geologi-

cally considered, they are a continuation of the neck of land, with which, though separated from it by these narrow channels, they are identical in structure and composition. They are composed of trap, under its different modifications, to the entire exclusion of every other rock; and like most islands of a similar nature when freely exposed to the ocean, they present scenery of unrivalled grandeur and magnificence. On the south side of Brier's Island near the entrance of the channel, the cliffs present a very striking assemblage of neat and regular columnar masses, which sometimes descend in lofty and continuous ranges of steps for many hundred yards into the sea; their serrated ridges rising up here and there from beneath its surface, and appearing, at first sight, like so much pier-work reared in defence of the island; which purpose, indeed, they may be said to answer in an admirable manner, since many of the masses scarcely break the surface of the water, and others are so concealed at shallow depths below it, as, in connexion with the currents that set in among them, to render an approach to the harbour dangerous even on ordinary occasions, and when directed by the most experienced mariners. We met with the wreck of a ship that had been driven in upon them a year or two since, and we were informed by the inhabitants, that the cargo and part of the unfortunate crew were lost. Situated as this island is, nearly in the direct route of vessels bound to St. John's, or up the Bay of Fundy, the danger of such accidents is not a little increased by the fogs and storms that suddenly close in upon this region, and which are sometimes known to endure for the continued space of three and four weeks. From the prevalence of these fogs, the island is comparatively barren of vegetation, and presents a dreary surface, affording only scanty support to the miserable sheep that

are kept upon it. Thus driven from the soil, the hardy inhabitants of the island resort to fishing as their chief employment. But this remark cannot be applied, as it unjustly has been, to many other parts of the Province, which, as respects soil and climate, are not surpassed, we believe, by any section of New England.

The columnar or basaltiform structure of the trap is exhibited in greater perfection and to a much greater extent, on this island than upon the opposite; but this is owing in a great degree to its being more exposed to the ravages of the ocean, which have developed the columns to a greater extent, and probably not so much to any intrinsic deficiency of the rock itself in exhibiting, externally, all its characteristic marks. They usually present five or seven sides, very smooth and perfect, and are very variable in their length and proportions, no less than in their internal characters; but as far as we traced them, they did not exhibit in their superposition, the depressions and corresponding convexities, so common to the trap of some regions. It is merely for the want of these characters, and a greater compactness in the mechanical arrangement of its particles, that this trap comes short of the genuine basalt of the most noted European localities. Indeed, the difference in respect to *internal* characters, on comparison with masses of basalt from the Hebrides, is found too slight to be made a point of distinction between them. No minerals were observed on this island, excepting a few narrow veins of red jasper occasionally encircling the columns; the amygdaloid, their usual gangue, not appearing along the coast so far as we followed it. We regret that foggy weather prevented us from passing round to the opposite shore of the island, where, as we were informed by the inhabitants, the cliffs rise to a more remark-

able height; but its character was clearly indicated by the long causeway, known as the "Bar," that runs out into the sea for more than a mile, and over which the billows were heard to roll in with great violence. From the information we obtained, we are led to believe that the substrata of sandstone are there seen to crop out from beneath the trap, thus making the western terminus of the North mountains similar to the Eastern.

At the northeast point of Long Island, the amygdaloid, on which the irregular columnar rock rests, is accessible, and its cavities are found filled with nodules of chlorite, to the exclusion of the zeolites, which, as we shall have occasion to show, more generally occur in other places. These nodules, when broken, present laminæ, of a beautiful leek-green color, radiating from the centre, and rarely crystallized in low tabular crystals, often intersecting each other. The chlorite has often been removed by external causes, thus imparting to the rock a vesicular appearance; but in some few cases, the cavities were naturally left void, constituting real vesicular amygdaloid.

The veins of jasper, as they traverse the amygdaloid, become singularly altered in their character, being converted into a substance, resembling in appearance imperfectly burned bricks of potters' clay. The specimens from the interior of the vein, where it had not been acted upon by exposure, presented the same appearance; some parts were in fact perfect clay-stone. As the veins entered the superincumbent trap, they became altered in appearance, and in the course of a few yards, were converted into a very perfect red jasper. Three or four veins were observed, presenting similar appearances.

In crossing Petit Passage, a deep and precipitous channel, through which the flood tides rush with great violence into the

Bay of Fundy, and form a dangerous "race-way," requiring, as we found, a very strong wind to counteract it, the first spot deserving of notice on account of remarkable geological features, is an indentation on the south side of Digby Neck, known as Little River Valley. Here the trap displays, with wonderful symmetry, its basaltiform structure, and presents a lofty precipice to the sea, where the river empties into St. Mary's Bay, composed of prismatic columns of three, five, and nine sides, frequently broken horizontally, and in some places imperfectly articulated, apparently by their motion on each other, occasioned by the sea; thus resembling in a striking manner, the basaltic rocks of the Giant's Causeway on the coast of Ireland. These prismatic blocks are usually two or three feet in diameter, and sometimes as many yards in length unbroken. Not unfrequently they have been dashed from their pedestals, and tumbled in confusion against each other, forming irregular Gothic arches, which, by their rude forms, give additional wildness to the scene. The exposed surfaces of the trap, from the additional oxidizement of the iron it contains, exhibit a brownish red color, but on recent fracture, its internal structure is fine-grained, and of homogeneous aspect, the hornblende being alone visible to the naked eye. It is heavy, tenacious, and sometimes sonorous. That it is magnetic, like the trap of some other countries, we think is clearly proved by the fact, that surveyors find their compasses very sensibly influenced in running lines in different parts of Digby Neck. But this influence they have hitherto erroneously attributed to large deposits of magnetic iron, of the existence of which there is but little evidence.

We have already observed that the local peculiarities and external forms of the trap rocks in this region, give it unquestion-

able claims to the title of basalt; but as we have no particular partiality for this term, and as the rock may differ in its internal characters from most of the basalt from Ireland, we have concluded to make use of the term columnar trap, leaving the question of its identity with the basalt of Ireland, to be decided by those better able to do it than ourselves; though we are aware, that some of the best writers on geology, do not admit any distinction between them. The experiments of Sir James Hall show very plainly, that the mechanical structure of trap may be coarse or fine, in proportion to the rapidity with which it passed, from its igneous or liquid state, into its columnar form; and therefore, as might well be expected, we meet with masses that differ widely in these respects at the same locality.

The next place of interest we shall mention, is Mink Cove, which is about five miles east of Little River. It is a harbour of inconsiderable depth, and presents nothing very peculiar in its geological features. A few interesting minerals, however, occur in the columnar trap and amygdaloid. They are red, yellow, and ribbon jasper, which traverse the precipice in veins from eight inches to a foot wide, and run for a considerable distance through the rock; the yellow jasper occupying the amygdaloid on which the columnar trap rests, passes, as it enters the more dense superincumbent rock, into red jasper of fine texture, often rendered more beautiful by zones of various colors winding in concentric circles through the mass. They are fit subjects for the lapidary's wheel, and when polished, constitute ornamental specimens. A curious mineral also occurs in the amygdaloid of this place, consisting of broad lamellæ of quartz, disposed in parallel and intersecting plates, having the interstices filled with calcareous spar, giving the specimens the appearance of alternations of

siliceous and calcareous sinter. The veins of jasper present geodes of quartz and amethyst, enclosing crystals of transparent white chabasie measuring nearly an inch across the rhombic planes; they are usually indented by the quartz crystals, over which they are scattered.

The next place worthy of notice is Sandy Cove, about five miles from the last described locality. This cove is the largest indentation on the coast of St. Mary's Bay, and from its favorable situation, it is considered the finest harbour. Its surrounding walls consist of trap, rising from the strand in huge sheets, nearly in a vertical position, and sometimes divided transversely into separate blocks or tables, that lie one above another with their connecting surfaces perfectly flat. They do not exhibit in their structure, the beautiful symmetry observed in the columns of Little River and Brier's Island; from which also, they differ in being of coarser texture, and in containing a large portion of green earth, by which they assume a distinct greenish hue. This difference in mineralogical composition and external figure, which we have also noticed at other places, seems owing to certain local causes, of which we shall speak in another place. It is a difference which is observed no less distinctly in other countries.

Nearer the head of the cove, the precipice gradually falls away, and a bank of brecciated and amygdaloidal trap takes its place, and abounds with nodules and geodes of many beautifully crystallized minerals. Their inner surfaces are sometimes lined with a delicate white filamentous substance, resembling fibres of cotton; apparently fibrous mesotype, similar to that found by Dr. M'Culloch on the Isle of Skye. We also met with interesting specimens of quartz, exhibiting the form of the primary obtuse rhomboid, in a few instances perfect, and measuring more than

three eighths of an inch in diameter. But usually the crystals are modified by the absence of solid angles and replacement of single planes, which, by their extension, tend to produce common six-sided pyramids. The amygdaloid is traversed by narrow and indistinct veins of specular iron ore, sometimes hollow, and enclosing white transparent chabasie. Not unfrequently, insulated crystals of the specular ore are imbedded in limpid chalcedony, thus forming a singular variety of agate.

But a substance more likely to interest the mineralogist at this place, is laumonite. This curious mineral presents itself, traversing the amygdaloid in veins sometimes a foot wide, running in vertical, inclined, and zigzag directions. The substances of these veins, especially the crystals, are more or less decayed, in situations most excluded from moisture; and the best specimens were found only in those places which were regularly covered by the tide. Into the cavities of these veins, the laumonite projects in beautiful groups of crystals, which exhibit the form of the primary oblique rhombic prism, firmly implanted at one extremity, and at the other terminated by a single rhombic plane, inclining from one acute angle to the other. The crystals are colorless and transparent, and frequently an inch in length. The calcareous spar which forms the walls of the veins, is often scattered over these groups in insulated rhomboids, considerably more obtuse than the primary crystals, and exhibits examples of hemitropic combination. Interspersed also with these, are brilliant spangles of specular iron ore, which give much additional beauty to the specimens, and serve at the same time to support the crystals of this fragile mineral. It is not a little singular that we have been unable to discover, in the form of the crystals of laumonite, the least modification by the absence of either edges or solid angles; while in

specimens from another locality, to be mentioned hereafter, it is as difficult to discover a single crystal which has not the addition of secondary planes.

The accompanying calcareous spar, like that similarly associated from Brittany, is exceedingly phosphorescent, emitting a beautiful gold-yellow light when thrown upon a heated plate of iron. But this property is by no means peculiar to this substance thus associated; for we have examined specimens from other parts of Nova Scotia, as well as from various localities in Europe and the United States, and find that all, without a single exception, possess this property, when placed on heated bodies. The Count de Bournon observed that from Brittany to be more phosphorescent than any he had seen from other localities; and we are unable to say whether this from Nova Scotia is equal to that, not having a specimen from Brittany in our possession.

About one mile east of Sandy Cove, the specular iron ore referred to, appears in more important veins, and affords specimens not inferior in beauty to those from Elba. When not massive, it occurs in flat, tabular crystals, often with curvilinear and striated faces, resembling many of the specimens of this substance from volcanic districts. Crystals, exhibiting some portion of the planes of the primary acute rhomboid, are sometimes met with attached to the gangue; but they are usually very much modified by replacements on their edges and angles. Magnetic iron ore also occurs at this locality, forming narrow veins in the amygdaloid; but neither of these ores occurs in quantities worth exploring. The best crystallized specimens of the latter, are found along the water-courses, in the soil that has been produced by the degradation of the amygdaloid that once surrounded them. Indeed, the soil is abundantly mixed with

large and very perfect crystals, in the form of the primary octahedron, exhibiting the passage of this form into rhombic dodecahedrons, which they sometimes complete, and thus become isomorphous with the Franklinite, which generally presents this decrement. They are also sometimes imbedded in earthy oxide of manganese, which occurs very sparingly.

Crossing from Sandy Cove to the Bay of Fundy, about the distance of one mile, we came to an indentation called Outer Sandy Cove, between which and the inner cove, is a small but extremely beautiful lake of fresh water, with a sandy bottom, and having a very diminutive outlet into the Bay of Fundy. These two coves are nearly connected by this little lake. The rocks at this cove present no remarkable peculiarities of structure. The shore is composed of immense sheets of trap of the amorphous variety, which shelve or dip towards the Bay of Fundy, at an angle of 10 or 15 degrees and finally disappear beneath its waters. The most interesting features of this place are the large veins of red jasper which appear in parallel ridges, resembling, in a striking manner, the brick battlements upon the inclined roofs of houses, and extending from the highest part of the shore to low-water mark. These ridges stand as monuments to show the continual effect of a turbulent sea, which has worn away the rock they traverse with comparative facility, and left them entire, or slightly polished, as obstacles to its further encroachments. They contain, in some places, geodes of quartz, amethyst, and rich specimens of agate, formed by narrow threads of red jasper traversing white transparent chalcedony, in a zigzag manner, and when polished, constitute beautiful specimens.

Following the shore of St. Mary's Bay, eastwardly as we leave Sandy Cove, and examining at low water the fragments

which have been detached from the precipices above, and profusely scattered along their base at the water's edge, we found in abundance agates of various kinds, and possessing great beauty. Some were of the variety called fortification agate, from a resemblance to military works, on the polished surface of the specimens. This variety is often found well characterized on the shore; sometimes in small nodules, which have been polished by attrition, and resemble the Scotch pebble in every respect: at other times it is found in large tabular masses, which are evidently the ruins of veins from the overhanging trap rocks. The specimens of this vicinity frequently contain the outlines of many fortifications in the compass of a few inches. The base of this agate is an opaque white chalcedony, alternating with rows of transparent quartz and yellow jasper, the last generally constituting the external layer. Fine brecciated agates were also met with, composed of angular masses of red and yellow jasper cemented by transparent and amethystine quartz, often enclosing, in geodes, beautiful crystals of purple amethyst, which, covering the whole interior of the cavity with protruding crystals, vie in beauty with any specimens brought from the banks of the Rhine. A large geode was found on the shore of St. Mary's Bay, which, weighing more than forty pounds, was composed almost entirely of the richest purple amethyst, the mass having but a thin coat of fortification agate externally. On an examination of the crystals of this geode, we found a substance of a reddish brown color, traversing the amethyst, in fibres or acicular crystals, which, beginning at the implanted extremity of the crystal, shoot out into diverging, scopiform, and fasciculated groups, to the opposite extremity. On exposure to a full red heat, this amethyst loses its color, becomes transparent, and has a vitreous lustre; the included fibres, at the

same time, are changed in color to a dark brownish black. On fracturing one of the crystals of amethyst, we obtained a portion of the fibres, which, on examination with the microscope, showed a reddish brown substance, with specks of a brass yellow, which we recognised as sulphuret of iron, the color being very speedily changed to brownish black by exposure before the blow-pipe, when it became magnetic, as did the surrounding brown substance. We are then led to conclude that the yellow is iron pyrites, and the brown fibres red oxide of iron, which doubtless had its origin from the decomposition of the former. The amethyst, traversed by this substance, is of a much deeper color than that in which it is not present, and the color appears deepest in the immediate vicinity of the fibres; hence we should be led to think that a portion of its color was derived from this mineral. The fibres are so minute, that we are unable to ascertain if manganese be present in them.

Large masses of red jasper, weighing more than a ton each, lie scattered along the base of Titus' Hill, which rises abruptly from the shore of St. Mary's Bay. This jasper is frequently of a fine texture, and is banded by stripes of various colors. Sometimes it appears to have been made up of rounded fragments of red jasper, cemented by chalcedony, thus being converted into brecciated agate; but this is not uniformly the case, for the fragments are more frequently encrusted with druses of quartz, which unite them to each other. Cavities of considerable size are found in these masses of jasper, having their interior surfaces lined with a covering of crystallized quartz, which projecting in stalactites from the superior part of the geode, to which they are attached by a slender neck, hang down into the centre, having the dependent extremity enlarged by a radiation of crystals.

Small portions of jasper are frequently included in the crystals, and give a beautiful appearance to the specimens.

On the coast of the Bay of Fundy, about six miles east of Sandy Cove, is an inconsiderable indentation, known by the name of Trout Cove. It presents but few interesting minerals. The situation of the rocks, however, is picturesque. The columnar trap is recumbent on amygdaloid, which here exists in a very narrow and almost inaccessible bed at the base of the precipice; the rocks have been tumbled in great confusion against each other, forming rude irregular passages under their walls. The only minerals to reward the collector for visiting this place, are some varieties of agate, which do not occur elsewhere on Digby Neck. They have a ground of highly translucent chalcedony of a blue color, with angular fragments of red jasper included, and are of a very fine texture; they improve much on the lapidary's wheel, and constitute beautiful specimens of this curious variety. The chalcedony has sometimes, imbedded in it, slender threads of blood-red jasper, which alternating with several different shades of color, twisted in zigzag directions, and preserving its parallelism with the others, constitutes a singular combination of fortification agate, and bloodstone in the same specimen, — the outworks of the fort being delineated by this blood-red zone. The agates occur, constituting veins in the columnar trap, which are seldom more than three inches wide. Chalcedony, of a very fine texture and smooth surface, and, on recent fracture, of a perfectly pure white, also occurs at this place. It occurs, like the agates above mentioned, in veins rarely more than an inch wide, in the columnar trap. This variety, on account of its fine texture and good color, appears well adapted to be worked into cameos and other ornaments.

The next place which we visited on the coast of the Bay of Fundy, is a cove, which has received the singular appellation of Gulliver's Hole. This cove is the largest indentation which the sea has been able to effect, on the iron-bound coast of the Bay of Fundy. It penetrates about three fourths of a mile into the land; and being narrower at its entrance, which is protected by massy columns of trap rocks, it affords a secure retreat to the small fishing-vessels which frequent these waters, when the wind is too violent for them to ride on the unsheltered coast. This locality will prove of interest to the mineralogist, on account of a curious variety of stilbite, which here occurs incrusting the walls of narrow, but deep and perpendicular fissures in the trap. On either side of these chasms, the stilbite occurs in compressed laminæ, projecting horizontally, or at right angles with the rock to which they are attached, for the distance of about an inch. They are crystalized, at their free extremities, in the form of the right rectangular prism, terminated by pyramids, and with numerous other modifications. The crystals are arranged in a very irregular manner, crossing and intersecting each other at right angles, so as to produce between them cellular interstices of various forms. The color of this stilbite is white, with a slight tinge of grey; it is glistening and somewhat pearly on cleavage; before the blowpipe it melts easily into a porous glass, without color and transparent. Large sheets of it are easily detached from the rock, by means of the hammer and chisel, and they form fine specimens of a singular variety of this mineral.

Magnetic iron ore in veins about a foot wide, associated with jaspery red iron ore, occurs in the trap rock at this place; but as the veins are exceedingly irregular in their course, and often terminate abruptly, little dependence can be placed upon them

for mining. This remark will apply to all the veins of iron ore which we discovered on Digby Neck; for although the ore is very rich, yielding as much as sixty per cent. of iron, it is so scattered in narrow, unprofitable veins, that it can never do more than supply the mineralogist with specimens of the objects of his science.

Proceeding in our researches eastwardly along the opposite shore, nothing of peculiar interest presents itself, until we reach nearly the extremity of St. Mary's Bay. This bay is separated from Annapolis Basin, by a narrow isthmus on which the town of Digby is situated, and which connects Digby Neck with a moderately elevated range of hills, to be mentioned more particularly when we treat of that formation. This isthmus, which no where attains an elevation of more than one hundred feet, is composed almost entirely of sandstone without presenting, so far as our examination has gone, any traces of marine or other organic relics. It undoubtedly underlies the neighbouring trap rocks of the North mountains, and supports them through their whole extent; but its junction with the trap was not observed at this place, though in a distant section of the North mountains it is seen rising up from beneath it, and forming the coast for a considerable distance. On the shore of St. Mary's Bay, a vertical section of this sandstone is presented, of about one hundred and fifty feet in height; spreading its broad face to the sea, and being the natural barrier against its violence, it has received the appropriate appellation of "the sea-wall." It consists of the red and grey varieties, alternating with each other in long parallel strata, running nearly north and south, and gradually inclining away at an angle of about ten degrees, till it disappears beneath the surface. The strata vary much in thickness, but from four

inches to four feet will include the limits of their variation. The first ten or twelve feet of the precipice include uniform alternations of the grey variety alone; above this succeeds a beautifully variegated kind, made up with white, grey, and variously shaded red-colored stripes, which, rising in continually widening strata, become gradually of a deeper red, and finally pass, distinctly, into the red sandstone, retaining this character through the remaining superposition of the strata. This red sandstone consists of minute grains of siliceous and calcareous matter, interspersed with spangles of mica. Attached to it are small beds of reddle, or red chalk, usually occupying the spaces between approximate strata, and preventing their actual contact. This variety is comparatively soft, and more readily acted upon by external causes than the grey, which has a much coarser, and by no means so uniform a texture. Both effervesce briskly in nitric acid, but the grey contains a greater portion of the calcareous ingredient. This sandstone does not contain veins of gypsum or limestone. In fact, the reddle was the only simple mineral which we observed in it. The entire precipice, from the feeble cohesion of its parts, is rapidly acted upon by the ordinary causes of decay; large masses are almost continually losing their hold above, and adding new matter to the slope of *débris*, which inclines from its base into the sea.

On the road to Digby, about three miles from "the sea-wall," we met with an interesting deposit of magnetic iron ore, although it did not prove to be a very extensive one. A collection of masses, in all about twenty tons, were found lying in the soil, and confined to a very narrow space on the south side of Nichols' mountain. The rock, in which they originally occurred, and which, by its decay, had left them disconnected, is amygdaloid of

a fragile character, presenting few or no mineral ingredients. On breaking these masses, they were found to possess a coarse granular structure, and sometimes to present, in their cavities, octahedral and dodecahedral crystals of great brilliancy and perfection. They were highly magnetic, and some of the masses possessed polarity. They presented beautiful druses of amethyst in violet crystals, projecting from grounds of chalcedony containing small globular masses of mesotype and calcareous spar. They also contain brilliant druses of quartz, presented in botryoidal and stalactitic forms. Occasionally, the amethyst, quartz, and chalcedony are united in one specimen, enclosing imperfect crystals of magnetic iron, and constituting, when polished, a singular variety of brecciated agate, showing the metallic concretions deeply imbedded in the transparent mass.

Near this place, a small stream takes its rise from the mountains, called William's Brook, which, running some distance southeastwardly, empties its waters into St. Mary's Bay. On the banks of this stream, near its source, we discovered veins of a radiated milk quartz in the amygdaloidal trap, coated externally with a thin incrustation of green earth, and having vacancies internally crystallized, and enclosing, in some of the geodes, a beautiful pearly white foliated heulandite, with stilbite often radiated, and sometimes intersected by the laminæ of heulandite. The two minerals being thus exhibited together in the same specimen, their distinguishing peculiarities are rendered much more obvious. Indeed the most unpractised eye readily distinguishes the bright pearly lustre of the heulandite, from the dull greyish white reflection of the stilbite. In the same geode with the heulandite, occurs a greenish mineral, crystallized in the form of the obtuse rhomboid, and possessing all the characters of chaba-

sie, excepting color. It is probably that mineral, colored by green earth. These masses often occupy the whole interior of the geodes, and are deeply indented by the pyramids of the surrounding quartz crystals; whence we suppose it to have been of more recent formation, or at least of more recent induration, than the quartz enveloping it. Botryoidal cacholong also occurs, encrusting the interior of the vacant cavities of the quartz. This locality will repay the mineralogical traveller for the trouble of a visit; and the course of the stream is a correct guide to the spot where specimens may be procured.

The only place which we have not already described, worthy of a visit from the geologist, is that part of Digby Neck where the North mountain range is interrupted by the Gut of Annapolis. This is two miles from the town of Digby. At this place, is situated the Light-house, which serves to guide navigators to the entrance of Annapolis Basin, the most capacious and secure harbour for large vessels in Nova Scotia, and one in which, as is observed by an historian of the country, a thousand ships may ride, secure from every wind.

The site of the Light-house is on a projecting rock of columnar trap of the most compact variety; and the numerous irregular crevices have been filled with chalcedony, jasper, and agate, which, adhering firmly to the contiguous rock, give it additional firmness, enabling it to resist successfully the fury of the waves, which, in boisterous weather, dash completely over the precipice, and wash from its surface every trace of soil or vegetation. The centres of the columns of trap appear to be more readily acted upon by the sea, than the parts contiguous to the chalcedonic veins, and thus concavities are produced, in which the spray from the sea, slowly evaporating, leaves crystals of its saline contents, as in natural salt-pans.

The rocks at this place are columnar trap, incumbent on amygdaloid, and present a surface exactly corresponding to that on the opposite side of the Gut, which is but half a mile wide, and appears as if it had been separated by violence, and not worn away by the action of the sea, which, however, at other places, has been a wonderful agent in undermining the lofty superstructure of columnar rock that skirts this coast. To the most remarkable of these we shall have occasion to refer hereafter. Des Barres, in his "Atlantic Neptune," has given several beautifully drawn views of the scenery of Nova Scotia, exhibiting the bold and magnificent features of the Bay of Fundy (equalled only by northern Ireland and the Hebrides), as well as of the tamer and more varied scenery of other parts, taken during the survey of this coast in the year 1779, by order of the British government. Among these, we have a picturesque view of the cliffs at the entrance of Annapolis Gut, just referred to, which, with some alterations making it more conformable to the *present* appearance of the spot, conveys so well the true character of this scene, that we gladly avail ourselves of this opportunity of bringing it again before the public eye, especially as the work of Des Barres has now become very rare; one perfect copy being all we met with in Nova Scotia. [See Plate I. at the end of this volume.]

Leaving Annapolis Gut, our attention will next be directed to Chute's Cove, which is about twenty miles from it. The intermediate coast we did not examine particularly, but sailed by so near it as to observe its more prominent features. It presents lofty precipices of trap rocks, and affords the mariner no harbour of sufficient security from the sudden gales that spring up on this coast. Even Chute's Cove, although it is considered the best,

and has a small settlement, will afford him a safe retreat only during certain winds, as it stands nearly open to the sea. The trap, composing the bottom of this cove, is in distinct columnar masses, the surfaces of which present, from the action of the sea, assisted by the motion of sand and pebbles, shallow, basin-like cavities, regularly curving from the centre up to the edge, which is harder, and formed of quartz and jasper, and in some places has become highly polished. The quartz and jasper are interposed between the columns like a cement, and very firmly attached to them. We observed several columns beyond the reach of the sea, which exhibited to a less extent the same appearances, proving, however, that ordinary causes have a direct tendency to produce these depressions on their surfaces. The minerals we obtained in our visit to this spot, were found about one mile west from the cove, where we met with an immense waste of water-worn and nearly globular masses of trap, running down like a pavement into the sea. Many of these masses are highly polished by attrition, and they frequently exhibit, on their surfaces, small globular concretions of heliotrope, or bloodstone, imbedded in a chalcedony of a very deep green color. This interesting mineral also occurs not far off in veins traversing amygdaloid, and exhibits, in the green chalcedony, which seems to owe its color to the green earth that frequently invests it, minute, thread-like, and diverging branches of a high crimson color. The chalcedonic part has a milky hue, and passes into carnelian.

At Chute's Cove, six miles east of the locality just mentioned, the rocks resume their abrupt character, and present lofty precipices of columnar trap resting on amygdaloid, abounding with zeolites. The shape of the cavities presented by this amygdaloid, is very singular; for instead of the spheroidal shape, in

which they usually occur, we are here presented with cylindrical cavities, from half an inch to two inches in diameter, and often more than a foot in length. They are mostly vertical or but slightly inclined, and sometimes branch in a curious manner. The interior of these cylinders is usually coated with a thin layer of green earth, over which an incrustation of beautiful crystals of heulandite is deposited. A considerable space is usually left void in the centre, and the projecting crystals are remarkably perfect, exhibiting many curious modifications on the primary form. The most common is the replacement of the solid obtuse angles, and the lateral acute edges by single planes, thus producing a hexahedral prism with dihedral summits. The heulandite is not always crystallized, but often entirely fills the tube with laminæ, intersecting each other in an irregular manner, as if it had attempted crystallization in a space too limited to allow room for the crystals to become perfect. They are evidently the product of one crystallization, for there are never concentric layers of this mineral in the tubes. These cylinders, studded with brilliant crystals of heulandite, constitute specimens highly interesting to the mineralogist; but the form and position of the cavities may be considered valuable evidence in accounting for the origin of the trap rocks. Our limits will not permit us to dwell on this subject sufficiently to weigh the evidence against any theory, but we may venture to hint at the evidence which may be derived from their form and position. If the cavities were produced by the expansion of an elastic fluid, the pressure being equal in all directions, a spherical cavity would necessarily be produced; and this might be converted into a cylindrical cavity or tube, by the hardening of that portion of the rock to which the upper hemisphere was attached,

and by a subsidence of the tenacious mass below, containing the other hemisphere. The tubes are often bent at right angles, as if the rock had been subjected to an alternate irregular elevation and depression. The occurrence of native copper in a similar cavity, a few miles to the east of this place, might probably be adduced as evidence that the production of this rock was attended with heat. In the instance referred to, there was a crystal of green analcime attached to a filament of native copper, which, projecting from the rock, probably served it as a nucleus on which to crystallize. The crystals of heulandite &c. were doubtless deposited subsequently to the formation of the cavities, as the incrustation always received its impressions from the irregularities of the tube, and never left any, although it received an indentation from the slightest prominence in the rock. The only way in which we can account for these cavities, on the supposition that the rocks were of aqueous origin, would be, to suppose the upright tubes to have been produced by the ascent of some elastic gas; but as the cavities are soon arrested by a dense superincumbent rock, and have no outlet, and at the same time diminish in size as they ascend, there is reason to suppose the cavities to have been produced by some condensible elastic fluid, as steam. Their position shows the force which produced them to have acted in a direction up and down, and their irregularities perhaps indicate the rising and falling of the liquid mass.

The inadequacy of any hypothesis to explain these appearances, if founded on the aqueous origin of the trap, is clearly shown, we think, by the evidence we have in favor of the opposite theory; a theory which satisfactorily explains the peculiarities referred to, and which derives no little support from, if it is

not confirmed by the precisely analogous phenomena presented by rocks of *known* igneous origin; such, for example, as the volcanic lavas and obsidians of Iceland and the Lipari Isles, cited by Mr. Scrope, in his able work on Volcanos.*

The occurrence, too, of similar cavities in the secondary trap of other regions, has been mentioned by several writers on geology, and in this country especially by Professor Hitchcock, who, in his valuable notices of the trap bordering on the Connecticut River, aptly remarks, that the rocks in which they there occur, "appear as if bored through repeatedly by an auger." † And in a paper which we have recently noticed in the "Transactions of the Royal Society of Edinburgh," ‡ written by Mr. Trevelyan, we find them mentioned as occurring in the trap of one of the Ferroe Islands. This careful observer ascribes their origin to the escape of an elastic fluid through the mass of this rock while soft.

We shall take occasion hereafter to show the relations of shale, red sandstone, and trap, in the production of trap tuff and amygdaloid; which will lead us to infer, that the vicinity of the trap is necessary to the formation of amygdaloid, and that the production of that rock was attended by heat. But before leaving this cove, we would mention, that foliated heulandite occurs in veins two or three inches wide in the amygdaloid, and that mesotype is found abundantly in the soil formed by the disintegration of this rock.

From St. Croix Cove, pursuing the coast easterly, the amygdaloid, crowned with columnar trap, continues and forms an abrupt precipice for about five miles, where it is again interrupted

* Page 113. † Silliman's Journal, Vol. VI. p. 52. ‡ Vol. IX.

by Martial's Cove. The rocks at this place, and the veins presented by the neighbouring coast, cannot fail to reward the labor of those who may visit this spot, as scarcely a week passes, without the downfall of some impending cliff, that scatters its treasures along the shore, before shaded by its brink. Here the heulandite is not confined to spheroidal masses as a mere constituent of the amygdaloid, but exists in veins sometimes six inches wide, extending vertically from the base of the precipice to its very summit. Some of them, that have fallen with the masses of trap, exhibit broad folia of a pearly white appearance. This heulandite, usually colorless and transparent, is sometimes of a red color, like that from Scotland and Germany.

But in speaking of the interesting productions of this place, we should not pass over a very curious, and, in fact, hitherto unknown association of analcime with native copper. The analcime occurs in the form of the primary crystal, and by the replacement of these planes on all its solid angles, presents the passage of that form into the trapezohedron. It is of a verdigris green color externally, but, towards the centre of many crystals, this color diminishes in intensity, and in some it entirely disappears, leaving them transparent. They also approach the emerald green. The copper is partially imbedded in these crystals, sometimes in globular concretions of about the size of a common pin's head, and at other times in minute filaments, having one extremity attached to the amygdaloid, in the cavities of which they both occur. These globules are soft and malleable, and, when scraped, possess the brilliant lustre of pure copper. The crystals presenting themselves under an aspect so new and beautiful, induced us to examine them more particularly in order to ascertain the nature of their coloring matter. As the amygdaloid contained a portion of

green earth, we at first ascribed the color to this substance, as it is well known to penetrate other minerals and impart to them a green tinge. But as a few of these crystals were covered by a thin film of a green carbonate of copper, it seemed probable that this substance might be the occasion of the green stain which more uniformly pervaded them. In order to ascertain it, we digested the powder of a crystal which contained no copper mechanically united with it, in nitric acid, and detected this metal in the solution by appropriate tests. It is probable that this metal may yet be discovered at this locality in crystals occupying the cavities of the amygdaloid, as has been observed by Mr. Allan in a similar formation in one of the Ferroe Isles.

The places which next demand our attention, are two eminences known as Hadley's and Gates's Mountains. They are situated near each other, and each attains the height of about three hundred feet above the level of the Bay of Fundy. The former consists mostly of amygdaloid, in which, in many places, nodules of chlorophæite take the place of the zeolites that usually occupy the cavities of this rock. These nodules are frequently half an inch in diameter, and are sometimes hollow, enclosing crystals of dog-tooth spar. Specimens of the chlorophæite, when recently broken, are of a greenish tinge, sometimes approaching leek green. It is translucent on the edges, and soft, yielding to the nail with about the same readiness as horn silver. Its fracture is distinctly conchoidal. On exposure to the air, the color changes, and the substance becomes black and opaque. This peculiar change is also observed in specimens, before being removed from the rock, even to the depth of six inches from the surface. We would observe, that this substance, from its deceptive appearance, has occasioned much speculation among the in-

habitants, and that a company was formed not long since, for the purpose of working it as an ore of copper. This mistake seems to have originated from the use of the mineral rod, which in Nova Scotia, as well as in New England, has led many an honest farmer into ruinous speculations.

At this locality, we were kindly shown specimens of heulandite under a form, we believe, rarely presented by this mineral. One was a mass nearly cylindrical, twelve inches long and one in diameter at the larger extremity, and consisted of brilliant, transparent laminæ placed at right angles to its axis. Its lustre was remarkably pearly, insomuch that it had for a long time been carefully preserved as a remarkably fine piece of "mother of pearl." It was invested with a delicate coating of green earth, and seemed, as it were, to have been painted artificially. It was found at St. Croix Cove, and obviously once filled the entire space of a cavity in the amygdaloid. We are induced to mention it, from its being a very perfect representation of the external form of this substance, as it occurs at that place.

Gates's mountain is very similar in its structure to the one just mentioned; but the minerals included in the amygdaloid are of a different character, and are so numerous as to render unnecessary even the ordinary labor of obtaining them from the rock, which, by its decay, has here left them naked in the soil to an extent sufficient to give it a white appearance. Most of them are in small masses, not larger than a pepper-corn; but among them were found globular masses of thomsonite and mesotype of the size of twenty-four pound balls. When broken through the centre, the masses of thomsonite present long and slender crystals, radiating from opposite points of the surface to the centre, where they meet and form small cells, in which may be ob-

served distinct, colorless, and transparent crystals in the primary form, and measuring more than an inch in length. These crystals are occasionally replaced on their solid angles and terminal edges, so as to produce low pyramidal terminations. This thomsonite agrees with that from Dumbarton in Scotland, in its chemical and physical characters.

The mesotype is in masses of a finely radiated or plumose structure, and when broken, presents, in the less compact parts, small intersecting fibres of a beautiful silky white appearance. Its texture, near the surface, is unusually compact, breaking with a splintery fracture; and some specimens in this respect, as well as in point of color, resemble the bones of animals, for which they are sometimes mistaken by the inhabitants, who plough them up from the soil of their fields. We did not observe in any of these specimens, well marked appearances of crystallization. Attached to the mesotype and thomsonite, are small masses of foliated stilbite and crystals of analcime. Several veins of magnetic iron ore occur on this mountain, but they are worthless, in a practical view, from their narrowness and inconsiderable extent.

The next place, which will prove interesting to the mineralogist, is Peter's Point. This name is given to a promontory, which, projecting into the Bay of Fundy, forms a shelter on the west to a small creek, into which a stream, sufficiently large to carry a saw-mill, called Stronoch's Brook, discharges its waters. The geological features of this place are similar to those at St. Croix Cove, excepting that the cylindrical cavities are here wanting, and the amygdaloid has been washed away from under the superincumbent columnar rock, which presents an overhanging precipice, threatening to crush the traveller who may venture beneath

its frowning summit, from which large masses of rock, detached by the frosts, are almost continually falling.

Near this point, under the protection of an arch of columnar trap, a deep cavity was discovered in the amygdaloid, which, having a narrow aperture, expanded internally to the diameter of six feet, in every direction. The mouth of this cavern being enlarged, so as to admit of examination, its walls were found to be thickly encrusted with laumonite in a remarkably fine state of preservation. Specimens were easily detached by the hand, and were found to consist of successive layers of radiating crystals, which, in the centre of the mass, were of a fine flesh-red color. The external surface of this crust, and the interior of cavities which frequently occur, were richly studded with transparent and colorless crystals, of great perfection and beauty. They are in the form of the oblique rhombic prism, terminated by a rhombic plane passing from one of the acute solid angles to the other, and almost constantly replaced on the acute solid angles by a single triangular plane resting on the acute lateral edges; these secondary planes are always small, and never obscure the primary form of the crystal. The cavities, in the laumonite, are often filled with water, which serves to prevent the efflorescence of the crystals, which are thus preserved in an unaltered state. The surface of this mineral is frequently enriched with crystals of calcareous spar, exhibiting the forms of the rhomboid more obtuse than the primary, and the scalene triangular planed dodecahedron. Large and perfect crystals of apophyllite, in the form of the square prism, generally replaced on the solid angles by single triangular planes, which are in various degrees of advancement, sometimes almost concealing the primary form, are found at this place. This mineral agrees perfectly with specimens in

our possession, which are from standard localities in Europe. The crystals are eminently axotomous, and this cleavage is so easily obtained, that it is with great difficulty the crystals can be preserved entire. The cleavages parallel to the sides of the right square prism are easily obtained, but the natural joints are not so open as in the direction of the terminal plane. It agrees likewise in chemical characters with the apophyllite from the Bannat; hence there can be no doubt of its identity with that species.

In visiting this interesting locality the second time in 1828, we were unable to gain access to this remarkable cavity, as the frightful cliff, that before hung over it, had fallen during the winter, and buried it among the ruins. But we met with other localities scarcely less interesting in this vicinity, in the numerous cavities and arches that have been hollowed out by the surges from the softer amygdaloid that is traversed by veins of a yielding nature; such as carbonate of lime and sandstone, the last rising probably from the immediate substrata of this rock, on which the trap reposes. These veins, at the inner extremities of the caverns, are frequently hollow and lined with stilbite, heulandite, and more rarely with apophyllite, in greenish white square prisms, an inch in length. Masses of laumonite, with surfaces more than a foot square, were obtained from them, and were found completely studded over with projecting crystals of great richness. One of these, we succeeded in preserving entire, and its crystals now possess all their native beauty and transparency. They show no tendency to effloresce when immersed in *spirits of wine;* a fluid which has great advantage over water in the winter season in not endangering the vessels in which the specimens are preserved. Between Peter's Point and French Cross Cove, the precipices

which rise in many places perpendicularly to the height of three hundred feet, exhibit very distinctly, as we pass them, the parallel disposition of the different beds of which they are made up. The precipice at French Cross, from its being accessible at low water, is perhaps as instructive as any. Here the lowest bed, which is about twenty feet thick, is a reddish amygdaloid, largely impregnated with spheroidal zeolites; the next is an amygdaloid of common appearance, and contains but few minerals in its composition, although it presents many cavities unoccupied. The third is rarely vesicular, and seems in fact to pass into amorphous trap. The fourth and last is composed of tabular and columnar trap rising in irregular columns to the top of the precipice. They all incline away at an angle of from five to ten degrees with the horizon, and are distinctly separated from each other throughout their whole course.

The stratified arrangement of these rocks is, we believe, an uncommon occurrence; at least, we do not remember to have seen it noticed but in a very few instances. Dr. M'Culloch has recorded an instance of it in his interesting paper on the Island of Staffa,* but there the precipice consisted entirely of the columnar rock, and the three beds composing it did not exhibit that peculiar relation of contact which distinguishes the one we have mentioned; nor did the precipice, compared with this, attain any thing like an equal altitude; and it would be much less difficult to assign the origin of *three* beds, which exhibit such similarity in structure, to one and the same epoch, than four which present great diversity in structure and mineral contents. They all *appear* to have been deposited at successive periods, and so long

* Transactions of the Geological Society of London, Vol. II. p. 504.

after one another, as to have affected no intimate union. The sandstone, although it does not appear as a part of the section exhibited, is immediately subjacent to it, and may be observed at several places along the coast cropping out from beneath the trap; the amygdaloid, where it comes in contact with it, being of a reddish color, evidently the effect of a partial admixture of the two rocks. The sandstone, in some places, to which we shall have occasion to allude, enters largely into the composition of the trap breccia, as well as the amygdaloid, and shows evident traces of igneous action.

The amygdaloid near this precipice furnishes good specimens of laumonite and mesotype; but the most abundant mineral it contains is heulandite, which, from the beauty of its crystals, we shall here describe. It occupies the interior of veins of jasper, and is sometimes found lining the surfaces of botryoidal chalcedony and geodiferous quartz. The crystals are in the form of right oblique-angled prisms with their obtuse solid angles replaced by triangular planes, and their acute edges replaced by one plane; they thus pass into hexahedral prisms. They are colorless and transparent. On cleavage parallel to the terminal plane of the prism, the laminæ present the brilliant pearly white appearance characteristic of this species, while the lateral planes often present a remarkable vitreous aspect. None of the heulandite however, from this locality, possesses the red color peculiar to that brought from the Tyrol. Specimens of it are frequently interspersed with stilbite in projecting bundles of crystals, which well show the characteristic difference between the two minerals. Analcime of a reddish color is also associated with it, and is probably that variety called sarcolite.

No further examination was made of this coast until we arrived at Cape Split. This bold promontory terminating the eastward limit of the North mountain range, projects into the Bay of Fundy, and the extremity of the cape, being broken into detached masses, has given rise to the appropriate name by which it is now known. In our former remarks on this cape, we stated, in accordance with the common opinion, that the detached masses referred to, had been suddenly separated, or split off, from the main cape by the undermining of the amygdaloid by the sea; but this opinion is evidently incorrect, as is shown by the present vertical or conformable position of their columnar masses to those of the main cape, in advance of which they are stationed; proving them to have been separated by the gradual degradation of the rock in situa. [See Plate II. of this volume.] * This cape forms the southern boundary of the strait called by the inhabitants the "Gut," which connects the waters of the Bay of Fundy with the Basin of Mines. It presents, on either side, a mural precipice of about three hundred feet, and is fifteen miles from Cape Blomidon. The intervening coast consists of columnar trap resting on, and alternating with amygdaloid. These rocks occasionally rise to a great height, especially about half the dis-

* This plate, from Des Barres' Chart, does not give so accurate a view of the present features of this singular spot as we could have wished, and the same may be said also of Plate I. taken from the same work. But we were unwilling to alter either of them very materially from mere recollection, and have therefore had them copied on stone very nearly as we found them. Notwithstanding the changes which the two places have undergone in the elapse of more than a half century, they yet convey a striking semblance of the peculiar physiognomy of either, and will instantly recall to the mind, the impressions that were previously fixed in it, while beholding, for the first time, the scenery which they are intended to portray.

tance towards Cape Blomidon, where they considerably exceed that of any other part of this coast, attaining an elevation, in one place, of four hundred and fifty feet, as was ascertained by the ingenious reflecting circle of Sir Howard Douglas, the late accomplished Lieutenant Governor of New Brunswick. At this place the amygdaloid is marked by numerous small and narrow veins of magnetic iron ore, coated over with grey oxide of manganese. The one is finely displayed in large and brilliant crystals that show the passage of the primary form into rhombic dodecahedrons. They are sometimes imbedded in red jasper and quartz, from which they may be taken out entire, so as to leave accurate moulds or impressions of their forms. Grounds of quartz crystals are often found sprinkled over with limpid crystals of analcime and calc-spar; the latter in acute rhomboids, some of which are hemitropes, and present deep striæ parallel to the natural joints of the primary crystal. Also apophyllite in massy specimens, that present on fracture, broad transparent folia of a high vitreous lustre, and in regular square prisms replaced on their solid angles, more than an inch in length. These crystals, colorless and transparent in their external laminæ, are occasionally found to enclose a smaller prism of uniform apple green color, which seems to have served as a nucleus, over which the colorless particles were subsequently deposited in parallel order; thus imitating the process by which a small crystal, some time after its formation, is converted into a larger one of the same figure. The distinct line of separation between the surfaces of the two, proves them not to have been formed at the same time; or points out at least a suspension in the process of crystallization. This is an interesting fact, which we do not remember to have seen noticed before.

We also met with interesting specimens of chalcedony, curiously marked by those regular stripes, or alternations of different shades of color, that are exhibited in the onyx agates of the lapidaries. They are sometimes arranged in little zones, which, if cut and polished, would resemble the stones sold under the name of "onyx eyes." The chalcedony is sometimes converted, apparently, by decomposition, into an adhesive cacholong, and is earthy and opaque. These minerals, like most of the others we shall mention, are obtained most conveniently among the loose masses of rock that skirt the shore; and it is fortunate for the collector of these objects, that he has thus at his ready command, treasures which would otherwise cost him great labor in obtaining, and for which, in clambering up the lofty precipices, he would besides expose himself to the no little danger of falling with the loose masses to which he may cling for support.

About one mile east of this locality, the amygdaloid abounds with analcime, in dodecahedral crystals transparent and colorless; but sometimes of an apple green color internally, and invested with on opaque white crust on their surfaces. But no separating line is seen between them as in the case of the apophyllite. Accompanying the analcime, we found a mineral resembling that variety of mesotype called needlestone. It occurs in tetrahedral prisms terminated by low pyramids, formed by four triangular planes resting on the terminal edges. One of the terminal planes is often extended at the expense of the others, which it sometimes nearly obliterates. It occurs in radiating and interwoven groups of crystals that proceed from a centre, which is sufficiently compact to yield a splintery fracture, and is white like ivory; they are transparent and colorless, have a remarkable vitreous lustre, and are sufficiently hard to scratch glass. They are often

beautifully interspersed with, and studded over the crystals of analcime, which they are never known to penetrate, but from which they receive impressions as if deposited at a later period. Accompanying the analcime and needlestone of this place, a mineral was met with in hexahedral prisms, which, agreeing in chemical and physical characters with no mineral described in the systems, will undoubtedly prove to be some new substance. It is identical with no species of the genus kouphone-spar of Professor Mohs, and the only minerals with which, from crystallographic characters, it can be supposed to be identical, are the colorless crystals of phosphate of lime from St. Gothard, and the sommite from Italy; from both of which, however, it is proved, beyond a doubt, to be distinct, by its very ready fusibility, its inferior hardness, and its unsusceptibility of dissolving or undergoing alteration when its smaller fragments are thrown into nitric acid. On comparing it with the Davyne, a mineral more recently discovered by Messrs. Monticelli and Covelli of Naples, and described in their *Prodromo della Mineralogia Vesuviana*,* it appears to possess many characters in common with that substance, having the same fundamental form, of which it presents the same modifications, and observes nearly the same proportions between the height and breadth of the crystals, but especially resembles it in its color, transparency, specific gravity, and pyrognostic characters. In its hardness, however, it is inferior to the crystals of that mineral, as it leaves no trace on glass, being softer than phosphate of lime, as we have before observed; a character of some importance, opposing as it does the identity of the two substances. It yields to cleavage very indistinctly, and only in a direction par-

* Page 405.

allel to the lateral primary planes of the crystals, though they present deep transverse striæ which seem to indicate an opposite cleavage, and which are not stated to have been observed in the crystals of that mineral; from which also it differs, in not being taken up in the smallest degree by nitric acid. The secondary planes of the crystals of this mineral, are usually more smooth and vitreous than the primary, which are roughened by striæ; and they disclose a perfectly transparent and homogeneous interior. These crystals are rarely three eighths of an inch in length. But we shall suspend any further remarks on this substance, until an accurate and careful analysis of it, now making by our friend, Mr. A. A. Hayes, is completed; as we may then be better able to show its identity with any partially known species, or set forth its claims to the title of one wholly unknown to the present catalogue of mineral substances. We were unwilling to pass on, without recording some notice of it, although we have not given a complete description of its characters, and have attempted only to identify it with some described species.

Hornstone, masses of agate, &c., occur scattered among the ruins of the trap rocks, which become entirely inaccessible as we approach Cape Blomidon. This cape forms an abrupt termination of the North mountains, or, as they are called in this district, the Cornwallis mountains, on the east. It presents us with a view of the outcropping of the sandstone, which here gives support to the trap rocks, and constitutes the chief part of the precipice, being more than three hundred feet high, and having the columnar trap resting upon, and scarcely attaining the elevation of an hundred feet above it. The sandstone forms a projection beyond the trap, which is called by the inhabitants of the country "the offset." This rock is regularly stratified, and dip-

ping at an angle of ten or fifteen degrees, passes beneath the trap, which it supports throughout the whole extent of the North mountains.

In our first short visit to this cape in 1827, we discovered in the sandstone no foreign remains, or veins of gypsum; but since, by taking advantage of another landing-place where it gradually slopes down to the water's edge, we have met with numerous veins of the gypsum, some of which, the fibrous and granular varieties, were more than a foot thick, and had been severed away and broken into smaller masses, by the falling of the trap rocks from above. Many of these masses presented the delicate whiteness of pure snow, and were in striking contrast with the huge masses of trap that were lying among them; others consisted of broad folia of transparent selenite. The only vegetable organic remains we observed, were a few indistinct casts of culmiferous plants highly carbonized; they indicated to us the probable existence of bituminous coal in the vicinity, and afford very positive evidence of the igneous origin of the overlying trap rocks, in converting them into their present charred or coal-like state. We were not, however, so fortunate as to meet with any regular beds of coal in this sandstone, so near its junction with the trap; a discovery, which would be of great practical value to the inhabitants, and which may yet be made. Nor were we enabled to remark in the two rocks any very decisive marks, evincing the former action of one upon the other, excepting that the distinct line of their junction was occasionally obscured by the passage of one into the other; and angular masses of them both were united into a sort of breccia, which assumed, in its finer varieties, the character of genuine reddish amygdaloid, of a semi-vitrified appearance, and having its cavities filled, as usual, with zeolites.

This appearance is observed at almost every place where the two rocks come in contact. We find the sandstone and the shale that occurs with it, gradually putting on the appearance of amygdaloid by admixture with masses of the superinduced trap, effected by some disturbing force; and the amygdaloid, thus produced, exhibits the small scales of mica that previously to the union existed in the sandstone; but they are deprived of their lustre. Almost every locality furnishes those illustrative specimens, in which we detect these fragmentary ingredients, forming first a coarse, then a finer, and lastly a true vesicular amygdaloid, the color of which, as we have said, depends on the relative portions of its materials. These, with other no less interesting and instructive phenomena, to which we shall presently allude, give great support to the theory of the igneous origin of the trap; and if taken together, we believe they cannot be explained without having recourse to it.

Before describing the capes and islands of trap rocks which project into the Basin of Mines, or are scattered along its northern coast, forming the outskirts of the North mountain range, and the limits of this interesting formation, it will be necessary to give a brief account of the situation and extent of this sheet of water. The Basin of Mines is of a scalene triangular shape, and, having its longest side formed by the township of Parsborough and the district of Colchester on the north, is sixty miles in length. The next side, which is forty-five miles long, is formed by the county of Hants; and its shortest by the county of Kings, for the distance of twenty-five miles. The greatest breadth of this basin is from Windsor to Parsborough, thirty miles. It communicates with the Bay of Fundy by a narrow, but deep strait, called "the Gut," which passes between the majestic walls of Cape Split and Cape D'Or.

This basin will prove interesting to the traveller, not only on account of the delightful villages seated on the banks of some of the many rivers which empty their waters into it, the picturesque and imposing scenery of its borders, and the enormous tides which here rise to the height of sixty feet with fearful rapidity, but also for the remarkably fine illustrations of the geology of the country and the interesting relations of the different formations, which are here presented in an unusually distinct manner. The geologist will delight to circumnavigate the whole extent of its coast, and explore the connexions of the different series of rock formations, the highly curious and important junctions of the trap with the sandstone, shale, &c. The collector of specimens in natural history, will also be richly rewarded for the perils to which he may be exposed, by the acquisition of many of the rare and beautiful productions of the mineral kingdom.

The most eligible, and only efficient mode of exploring this coast, although not free from danger, is by means of a boat, not so large as to be incapable of being rowed in case of failure of wind; for, besides the difficulty of transporting specimens, the traveller is constantly in danger of being caught, beneath the insurmountable precipices, by the rapid influx of the tides. An accident of this kind having nearly happened to ourselves in examining the geology of Cape D'Or, where we were under the necessity of making our escape by clambering up a mural precipice three hundred feet high, which was effected with great risk of falling with the detached columns on which we depended for support, we think it our duty to warn our successors of such hazards, and to recommend a boat as the means of safety in such emergencies.

The trap rocks compose most of the islands that are scattered along the coast of the Basin of Mines, and most of the capes that make into it. We shall describe them, for convenience, nearly in the order in which they were examined; beginning with the Island situated about five miles off the coast of Cape D'Or, and proceeding thence to the eastward. This island from the great height of its rocky cliffs, which, as we are told by Des Barres, seem to overhang on its northwest side, has been appropriately designated by the French, Isle Haute. It presents phenomena of the most interesting character, and, in some respects, is unequalled by any other spot in Nova Scotia. In ascending the bay, it was the first object that opened upon our view; but it was seen only by the looming or refraction of its dark surface by the fog, in which it seemed suspended, and which completely obscured the real substance of the island, until we very nearly approached it. This beautiful appearance was also no less strikingly presented by the elevated parts of the neighbouring coast, and formed, by the illusion, one of the most curious spectacles we ever witnessed. We reached the island nearly at low water, a circumstance, we should observe, of great importance to all who may visit it, as from the great rapidity of the tides and conflicting currents, which here rise to the height of sixty feet, it is difficult and even dangerous to land at any other time. Like the neighbouring coast, it is composed entirely of amygdaloid and columnar trap, varying greatly in its features and altitude. On its western front, it rears itself boldly to the surges, in a cliff about three hundred feet high, and is considerably undermined at its base; while, towards the opposite shore, the surface of the Island inclines away in a regular escarpment, and terminates in a comparatively low cliff. Its features are also much less bold on its northern

shore; but here the deficiency is fully supplied by the beautiful and conspicuous manner in which the shattered ridges and irregular colonnades of columnar trap are seen to rise from the water's edge, in shafts from fifty to an hundred feet high, and divided horizontally into blocks of variable height and proportions. These blocks are never more, and usually much less, than a foot in diameter. Their length is generally about three times their diameter, but they rest upon each other with perfectly flat surfaces. Some of them are curved or bent over in groups that strike the eye with singular interest; appearing to have been pressed over into this posture, by some power that had acted upon them before they had completely consolidated, or while their particles were yet in a state of mobility. And it appeared to us, on viewing them, as if this happened while the mass of trap was passing into its solid form. Appearances analogous to them, we are aware, have been observed, doubtless in a more remarkable manner, if we are to judge from pictured representations of them, in other trappean districts; but, even here, they form an interesting scene, and one, which, if taken in connexion with other facts, affords us some clue, at least, into their origin, and the nature of the agent by which it was attended. We are aware that a distinguished writer, Dr. M'Culloch, in some one of his papers, has said that it is useless to attempt the explanation of such columns, until we have something more rational to offer in regard to straight ones; an observation certainly not to be overlooked, but one, perhaps, which could be made with much greater confidence ten years ago, than at the present time; for it can hardly be supposed that the able investigations of Mr. Scrope, Professor Daubeny, and other writers on the continent, have not since thrown some new light on the origin of trap rocks, and the

anomalous and grotesque forms occasionally assumed by them. They refer us to the striking analogies subsisting between secondary trap rocks, and the more recent volcanic lavas, as exhibited in their columnar configuration and arrangement, their cellularity and texture; and, by these analogies, clearly deduce their origin from similar, though, it may be, very remote causes. It is obvious therefore, that the occasional incurvated appearance of the trap referred to, is explained as easily as the same thing when shown in the columns of lava, and is, in both cases, probably the mere effect of some lateral motion given to the mass at the time it was beginning to develope its columnar structure from its previous state of igneous fluidity. In mineralogy too, we meet with similar appearances, though on a smaller scale, as, for example, in the curved or bent up crystals of scapolite, sillimanite, sappare, and some others, which are not only curved, but are bent nearly double, and are sometimes even broken off at their centres, as if, in hardening, they had become too brittle too yield any further without separating at those points.

It is among the hexagonal masses of the trap composing this island, that we meet with those possessing the greatest symmetry of form. Some of them, indeed, have almost the symmetry of crystals; but they are not so smooth as the regular blocks of trap brought from Ireland, and, internally, they are of a coarser texture, resembling more nearly some of the masses brought from the Western Islands of Scotland. In their simple mechanical texture, they vary considerably, as might well be expected in reasoning from their origin; but this is a character which has little or no weight, from the very circumstance of its being so variable. The island presents many crystallized mineral substances that cannot fail to interest and enrich the traveller. But

as they agree with those we have already described, with some minuteness, and as the island, in respect to its minerals and structure, is marked by an identity of character with the neighbouring coast, with which it is doubtless coeval, we shall not enumerate them, or enter more at large upon the peculiar characteristics of its scenery, but take leave of it by remarking that it deserves the careful attention of naturalists, as well as lovers of the picturesque. Cape Chignecto we did not visit, but approached it so nearly as to ascertain its composition to be of trap, like the adjacent cape next to be described. It was personally examined by our friend Dr. Benjamin Lincoln, who has kindly communicated to us many interesting facts relating to the geology of the county of Cumberland.*

The trap forming the extremity of Cape Chignecto extends back in the county of Cumberland nearly to Apple River, where it meets the sandstone hereafter to be described and terminates abruptly; the sandstone coming boldly in contact with the trap, and not dipping beneath it as usually happens. The strata of this rock are nearly horizontal, and Dr. Lincoln suggests the probability of a fault existing in the strata at this junction. This cape deserves a more attentive examination to determine if this be true, as it must have an important bearing on the theory of the origin of trap rocks, and would lead to the opinion that the weight of the superincumbent rock had caused the fragile sandstone to yield to its pressure, and thus accomplished the dislocation of the strata.

* We are happy to have it in our power to state that Dr. Lincoln has obtained a large collection of the indigenous plants of Nova Scotia, of which it is to be hoped he will offer the public some account, as this interesting branch of the natural history of that country has hitherto been greatly overlooked.

Cape D'Or, situated at the mouth of the Basin of Mines, presents a mural precipice, attaining, in some places, an elevation of four hundred feet above the level of the sea; and is composed of amorphous and irregularly columnar trap, resting on amygdaloid and trap-tuff or breccia. From the yielding nature of the two last mentioned rocks, which form the base of the precipice, deep caverns and irregular arches have been formed beneath the superincumbent rock by the beating of the angry surges against its walls, while a shelving platform of trap-tuff remains below the surface of the water, and is left exposed only by remarkably low tides. This trap-tuff is a breccia composed of angular and irregularly rounded masses of compact trap, amygdaloid, and red sandstone, united by a softer cement of the same substances. The sandstone at this place makes up but a small proportion of the breccia. The crevices in this rock are frequently occupied by irregular masses of native copper, which generally are indented by the surrounding matrix. They are rarely arborescent, and never distinctly crystallized. Where exposed to the action of the waves, the copper is always bright, and may be seen for some distance beneath the water; but, where it is beyond their reach, it is usually coated with an incrustation of the carbonate or oxide of copper. The individual pieces seldom weigh more than one or two ounces, but masses are said to have been found lying detached among the fragments of rock, one of which weighed fifteen pounds. The name of this cape doubtless originated in the supposition that this metal was gold, and was bestowed by the French emigrants, who were the first Europeans that peopled Nova Scotia. The brilliancy and unusually yellow color of this copper might easily have caused this error, as it led us to suspect it might be an alloy of that or

some other metal; but on chemical examination, it was found to dissolve entirely in diluted nitric acid, and gave no precipitate when tested with muriate of soda, or when largely diluted with water, or when treated to excess of saturation with aqua ammoniæ. It does not contain, therefore, any gold, silver, antimony, or iron, the only metals suspected to be present. The copper is confined, exclusively, to the brecciated and amygdaloidal trap and never occurs in the superincumbent columnar rock. As it is never collected in any regular veins or beds, but is only scattered in small masses through the rock, it is probable that this metal will never be advantageously explored at this place; and as it occurs chiefly below the level of high water, the shafts would be liable to be filled at the periodical influx of the tide, if indeed the works were not entirely demolished by the violence of the currents. The sanguine expectations excited by the appearance of this metal, in a state of purity, must then be disappointed.

Masses of calcareous spar, and crystals of analcime, tinged green by the carbonate of copper, and having slender filaments of copper enclosed in them, occur in the cavities of the amygdaloid which rests on the trap-tuff.

On the eastern side of Cape D'Or, the precipice assumes a concave form, and has received the characteristic appellation of Horse-shoe Cove. Here the cavities in the amygdaloid are of greater dimensions, and are frequently occupied by crystals of transparent analcime, which are grouped together in congeries of large and small crystals.

Calcareous spar here occurs in long slender hexahedral prisms, projecting into and intersecting the cavities. They are curiously interwoven with each other, and are richly encrusted on their surfaces with small but perfect crystals of stilbite. The

specimens are very prepossessing in appearance, and would, from their resemblance, be mistaken for the crystallizations of sugar, which adorn the shops of confectioners.

The stilbite occurs, also, in radiating groups of crystals, forming beautiful stellæ, which are distributed through the enveloping masses of calcareous spar.

Many other minerals occur at Cape D'Or; but, since they are such as we have already mentioned as occurring at other places, we shall not here repeat the notice of them.

Leaving Cape D'Or, we pass Spencer's Island, which is situated about a mile from this cape. It is composed of columnar trap, and adds much to the picturesque appearance of this region, although it presents no objects of natural history worthy of description. The altitude of this island is nearly equal to the diameter of its base, and standing alone, like a tower in the midst of the waters, it breaks, in some degree, the violence of the surge, which rolls into the Basin of Mines from the Bay of Fundy.

Proceeding along the coast towards the east, up the basin, we pass the more tame scenery of the sandstone and shale districts to be described hereafter, and do not meet with the trap, until we arrive at Cape Sharp, which is fifteen miles from Cape D'Or, and about four from Cape Split on the opposite shore, with which it is shown in Plate II.* The promontory of this cape is composed of the amorphous trap, which scarcely exhibits any traces of columnar arrangement. The trap forms

* A nearer view of this cape, as it appears from the east and shows itself recumbent on red sandstone and shale, may be seen in Vol. XV. of Professor Silliman's "Journal of Science."

a precipice or "bluff" which exhibits a remarkable contrast to the low sandstone hills with which it is connected; and standing between them and the sea, serves to protect them from its ravages.

This cape will not furnish the collector with any mineral specimens of interest; but as this was the first place where the junction of the sandstone, shale, and trap was observed, it deserves to be mentioned on account of its geological interest. The sandstone and shale, which will be particularly described hereafter, are seen at this place to dip beneath the trap, at an angle of twenty or thirty degrees, and, in their passage, are observed to become singularly altered in appearance. The strata of these substances, before regular and distinctly parallel, are found altogether broken up and lying confusedly in various directions; the sandstone has changed to a dark red color, is more compact, and has become intimately blended with the shale, so that the eye with difficulty distinguishes the substance peculiar to each. The sharp angular fragments of the trap are next observed, and the whole becomes a distinct breccia, growing more compact as it dips beneath the superincumbent rock. The portion of the breccia in contact with the trap exhibited the small cavities of vesicular amygdaloid, as it passed into its dominion, and led us to believe that the shale and sandstone combined with the trap, and produced amygdaloid by their union. The numerous instances, in which this occurred, as it did in fact at every junction of these rocks in Nova Scotia, and the absence of trap-tuff and amygdaloid in places where this did not happen, or where, although the sandstone, &c. were not visible, it could fairly be inferred to exist beneath, led us irresistibly to this conclusion. That this process was attended by heat is inferred from numerous circum-

stances, a few of which may be mentioned here, and others in treating of the two great divisions of the country which remain to be described. The occurrence of native copper in the trap-tuff and amygdaloid, and the unreduced ore of this metal in the sandstone beyond the influence of trap, may be regarded as evidence in favor of this; while the conversion of claystone into fine red jasper, as it entered the superincumbent trap, the cylindrical cavities in the amygdaloid at St. Croix Cove, and even the existence of vacant spheroidal cavities may be considered as internal evidence in support of the same theory. The change of color in the sandstone from grey to red, the compactness of the strata as they approach the trap, and the charred state of the vegetable remains in the contiguous strata, afford sufficient proof, that, during the formation of the secondary trap in Nova Scotia, there was considerable heat. The sharp fragments of the breccia, and the breaking up of the strata, also show, that the production of this rock, or rather its non-conformable position on the sandstone strata, was effected suddenly. Whether it was ejected from the inaccessible depths of the Basin of Mines, or was thrown directly up through the strata of sandstone, we cannot determine; but the occurrence of the trap only on the borders of the basin would lead us to the belief that this cavity was the crater, if it may be so called, from which, in former times, the trap rocks issued; while the North mountain range, with but little breadth compared with its length, and but once broken in its continuity, seems to have been thrown up by one sudden and violent eruption from the unfathomable depths of the bay of Fundy, which is now skirted by its ancient lava.

If we were biased in favor of any theory of the earth, when exploring these formations, it was for that of Werner; and be-

coming satisfied of the insufficiency of the Neptunian method to account for the phenomena observed in the North mountains, and the appearances assumed by the neighbouring strata, we were induced to allow the superiority of the igneous theory, as taught by Hutton, Playfair, and Daubeny.

In treating of the South mountains we shall perceive the necessity of an amalgamation of both theories, to explain the relations of that range to the North mountains.

Partridge Island, situated near the village of Parsborough, and six miles from Cape Sharp, is the next place to be described. In crossing the Basin of Mines, after passing the majestic Blomidon, this island is the first elevated object that meets the eye. It consists of amygdaloid and columnar trap, which, on its south-west side, presents a precipitous and overhanging front about two hundred and fifty feet high, rendering precarious the situation of those who may pass beneath its brow. Stationed near the verge of this precipice, the visitor beholds beneath him rugged, insulated towers rising abruptly from the sea almost to a level with his own standing, which, having withstood the frequent commotions of the sea that during the stormy winter months is thrown among them in the most frightful billows, yet remain as firm and immovable barriers to resist the force of these repeated attacks, and prevent the more rapid decay of the island. Their summits are crowned with a thin but luxuriant soil, from which spring up a few scattered hemlocks and a low underbrush, that nearly obscure the face of the rock, but at the same time furnish the sea bird a safe retreat beyond the reach of any invader. But at low water the visitor, in addition to the wildness and picturesque beauty of the scene, will find before him a field so richly stocked with interesting minerals, that he will delight to linger on the spot and gather these objects of science. (See Plate III.)

Before alluding to these minerals, we would observe that the compact trap forming the highest parts of this island is rarely in masses which may strictly be called columnar, although they have a tendency to that form, and, in a few instances, affect the pentagonal shape of basalt. We were unable, however, to discover among them any appearance of articulation in their columnar arrangement. It contains but a small proportion of iron; and consequently the exposed surfaces of the rock are very slightly altered by the oxydation of this metal, which in other places is more sensibly observed.

Of the many interesting minerals to be found at this place, stilbite associated with calcareous spar is the most abundant. This mineral, forming numerous veins in the amygdaloid near the base of the precipice, presents, in the open interstices of the rock, beautiful projecting masses composed of long fasciculated crystals of a flesh-red, and sometimes straw-yellow color. When crystallized, it is in elongated, rectangular, four-sided prisms, terminated by tetrahedral pyramids.

The calcareous spar is curiously scattered over the surfaces of stilbite in acute rhomboids, which are often hemitropic, deeply striated upon the faces of cleavage, parallel to their horizontal diagonals, and of uncommon magnitude and beauty. These crystals, usually colorless and transparent, are in a few instances of a rich honey-yellow appearance. In breaking the various masses which are scattered along the shore, it is not unusual to meet with one, which, composed of yellow stilbite externally, contains within numerous crystals of calcareous spar lining its walls in rhomboids, which, having their faces deeply indented by the projecting pyramids of the stilbite on which they are implanted, were obviously deposited subsequently to the formation of that mineral.

Chabasie in rhombic crystals, transparent and colorless, also of a beautiful orange-yellow color, occurs at this place in the fissures of the amygdaloid. The crystals present brilliant glassy faces, and are very large, frequently measuring an inch across each rhombic plane.

Agates of various kinds, jasper and chalcedony, also botryoidal cacholong, exist in the columnar rock above the accessible base of the precipice: they may be picked up in imperfectly polished masses among the loose rocks on the shore. A vein of magnetic iron ore, about a foot wide, was also noticed entering the superincumbent rock.

On our return to this island and the neighbouring coast in 1829, the effects of the past winter were strikingly manifest; for many of the lofty mural precipices, which before constituted the most extraordinary and imposing features of this coast, were brought low, and reduced by their downfall to mere masses of *débris* heaped up on the sea shore. This was peculiarly the case on the west side of Partridge Island, from which the immense mass of rock had fallen, that before bulged out in the most terrific manner, and to a great height. But these catastrophes are common in this quarter, and are owing to the violence of the tides and currents in the Bay of Fundy, driven fiercely by the winter blasts.

The fallen masses on Partridge Island, besides presenting us with a rich variety of the minerals we have already described, disclosed one or two substances hitherto unobserved in Nova Scotia. They are phosphate of lime, semi-opal, and the variety of apophyllite, known as albin. The first is met with in very brilliant, transparent, hexahedral prisms, with their lateral and terminal edges, and sometimes solid angles, replaced; or in regu-

lar six-sided prisms, whose pyramidal terminations correspond very nearly with the lateral planes of the crystal. Though usually much smaller, they resemble in color the beautiful crystals of the asparagus stone from Spain; and as the *want* of phosphorescence is said to characterize that variety, they lay claim to the same title. But we find on trial, that phosphorescence is not confined to the common varieties of the calcareous phosphate, but is even possessed by some of the asparagus stone from Spain. The crystals at this locality, are imbedded in thin folia of siliceous sinter, that occasionally forms irregular shaped masses adhering to the veins of calcareous spar with which they have come down from the cliff. They are often interspersed with small shining scales, or tabular crystals, of specular iron.

The opal presents itself in specimens that are well characterized, of a wax-yellow color with a resinous lustre approaching that of pitchstone; it is translucent at some distance from its splintery edges; and in these respects it principally appears to differ from the jasper with which it is associated, and into which it evidently passes. Like the former, and the next substance to be mentioned, it is rare on this island, and has not been met with elsewhere in Nova Scotia. The albin, accompanying large and beautiful sheafs of yellow stilbite, is in opake, nearly milk-white crystals, some of them resembling, in their modifications, the crystals of this mineral from Bohemia. The terminal edges of the primary right-square prisms are replaced by single planes, which, extending over the lateral planes of the crystals, produce two four-sided pyramids, and thus result in octahedrons with square bases. But usually these replacements do not greatly obscure the primary figure of the crystals. They present striæ parallel to their base, in which direction they readily

cleave. Some of them have gone through a spontaneous change, and separated into a powder, similar to that resulting from the disintegration of laumonite. But we should not omit to mention in this place, that the substance for which this island more than any other spot in the country has been celebrated, and in search of which it is visited by almost every traveller, is amethyst, in crystals of great beauty and brilliancy. They seem first to have drawn the attention of De Monts, one of the earliest French emigrants to this country, during the reign of Henry IV. It is said he was so struck with their appearance, that he took several specimens with him to Paris, where he had them appropriately set as jewels, and presented them to the King and Queen as tokens of his loyal attachment. They often form geodes in the amygdaloid, and are externally encrusted with chalcedony and cacholong that alternate with each other.

Pursuing the northern shore of the Basin of Mines eastwardly, the next place deserving of notice is the vicinity of the Two Islands, about six miles from Partridge Island. The intermediate coast, being composed of rocks of a different character from those which it is our object at present to describe, we shall leave, to notice it more particularly when we treat of that formation.

The Two Islands consist of amygdaloid and columnar trap rising on all sides abruptly from the sea; but, being accessible only at low water, they will not afford the visitor many interesting specimens. On the main land near Swan's Creek and opposite to these islands, he will be favored with a locality of uncommon interest. At this place we have also another example of the conversion of shale, red sandstone, and compact trap, first into a coarse breccia, consisting of loosely united masses of these

rocks, then into a more compact breccia, consisting of similar masses more closely united, though distinguishable from each other, and finally, by consecutive gradations, into a genuine, well characterized amygdaloid, in which the most critical eye would fail to distinguish its component ingredients. We have in our possession specimens from this place, which illustrate perfectly the changes of which we speak, and present these three rocks tending to the production of amygdaloid.

Having thus adverted to the character of this rock in particular, we shall notice more generally the appearance of the rocks at this place, and then describe the minerals before alluded to as occurring in them. The shore is fronted by a steep bank about one hundred feet high, from the base of which a slope of *débris*, detached by the frost, inclines down into the sea. One half of this bank consists of trap, and the other of red sandstone intermixed with red shale. Upon it rests a low ridge of columnar trap. These two rocks come boldly into contact with each other, and the sandstone with the shale, dipping beneath the trap at an angle of forty degrees, has the breccia and amygdaloid recumbent on, or more properly, inclining against it; thus presenting, when viewed from the sea, a section of the two rocks crowned with the columnar trap. The amygdaloid is vesicular, and furnishes most of the minerals which we are now to describe. They are chabasie, analcime, heulandite, calcareous spar, and siliceous sinter, all of which occur abundantly, and are often seen richly congregated in the same specimen, or included in the same cavity of the rock.

The chabasie, grouped with its associated minerals, is usually of a wine-yellow or flesh-red color; but in a few instances it is nearly colorless and transparent. The crystals, which are frequently three fourths of an inch in diameter, exhibit the form of

the primary obtuse rhomboid, sometimes so modified, as to assume the lenticular hemitropic form represented in Phillips's Mineralogy, p. 138. At other times, from the almost innumerable faces of composition, they become indescribably complex, or at least would require, for a precise crystallographic description, the consummate skill of a Haüy, a Mohs, or a Brooke. They are slightly striated, of a glistening vitreous lustre, and often hemitropically united. This chabasie agrees in all characters, excepting color and complexity of modification, with that from the Scotish Islands.

The analcime is in white, opake crystals, exhibiting the passage of the primary cube into the trapezohedron, which it frequently completes, and thus forms crystals having twenty-four equal and similar trapeziums which entirely obscure the primary planes.

Over the analcime, the heulandite is thickly implanted in small, but extremely brilliant, pearly-white crystals, which are transparent or translucent, and usually in the primary form, sometimes slightly modified.

The calcareous spar is crystallized in very acute rhomboids, of which scarcely two can be found possessing similar angles. The crystals are likewise so modified, as to assume the form of the dodecahedron composed of two scalene six-sided pyramids, applied base to base. They are greatly elongated, and grouped in delicate stellæ, occupying the cavities of the amygdaloid.

Delicate prismatic crystals, but not of sufficient size to enable us to determine their form, resembling the Brewsterite from Scotland, occur scattered through the cavities of the trap-tuff and associated with perfect and distinct crystals of analcime, constituting interesting specimens.

The last of the minerals which we shall mention as occurring at this locality is siliceous sinter. This mineral is usually embraced in the amygdaloid, forming, in its spheroidal cavities, a flaky or lamellar crust, which, enveloping their entire inner surfaces, sometimes depends in stalactitic projections, on which may be observed small crystals of common limpid quartz. Its color, which is usually snowy-white, or greyish-white, is in a few instances of a beautiful amethystine tint. One or two geodes of this substance found in the breccia, on being broken, presented internally a bright coating of amethystine sinter with numerous crystals of wine-yellow chabasie implanted in and beautifully contrasted with it. Many of the specimens of this sinter resemble those of volcanic origin, brought to this country from the Azores by Dr. Webster.

The next place to be noticed along the northern shore of the Basin of Mines, is the Five Islands, and an eminence known as Tower Hill. Our description of these places will include all that remains to be said relative to the trap rocks, of Nova Scotia. These islands, grouped together in a narrow compass, are about ten miles from the locality last described; they rise very abruptly from the sea, and present, for the most part, lofty fronts of a picturesque character. Three of them consist almost entirely of trap and cannot well be examined except at low water. The other two are composed of red sandstone, with red and black shale, exhibiting the passage of these rocks into a vesicular and zeolitic amygdaloid, the color of which depends on the proportions in which the ingredients form a part of it; it is sometimes made quite black by the shale. The breccia, or trap-tuff, which is a constant attendant of this amygdaloid, and which seems as an intermediate form necessary to the constitution of the latter, is

here observed, as in other places of similar character, superincumbent on the amygdaloid. To plate IV. the reader is referred for a view of a part of these Islands taken at some distance; of which two are shown to consist of columnar trap, besides the steep sugar-loaf masses, provincially termed the "Pinnacles," that rise up in the rear, the highest of which is about one hundred feet, and is wholly inaccessible. The third, formed in part of sandstone (colored red on the plate), has been worn away on its west side, so as to exhibit a very fair sectional view of the junction of this rock with the trap; the two, at the very point of contact, becoming blended as usual into trap-tuff and amygdaloid. The trap is not strictly recumbent on the sandstone, at this place, but more properly rests inclined against it. The island most noticed of the five, is that which stands out considerably in advance of the others, and of which a few words only will convey as accurate an idea as a full drawn picture. It is composed of amorphous or indistinctly columnar trap, resting on a softer basis of amygdaloid, which has been so undermined as to leave the columnar rock hanging over from above, like a vast leaning tower, and seeming at every moment as if ready to fall into the sea. These islands, with the exception of Tower Hill, of which the trap forms the summit only, are the last places along the shore of the Basin of Mines, at which this rock is known to occur. Still farther east, the sandstone, interstratified with the shale, prevails to the exclusion of every other rock. They may be regarded therefore, as the most distant outskirts of the trap formation of Nova Scotia, which, stretching east and west to the distance of not less than one hundred and thirty miles, forms, as a deposit of trap-rock, one of the most extensive and fruitful fields for mineralogical and geological research that the known world presents.

Unlike most other extensive formations of this rock, its breadth is altogether disproportionate to its length, not exceeding in any place three miles, and in some places, where it has been worn away into deep ravines on the sea coast, scarcely exceeding a hundredth part of its extent in the opposite direction. If averaged, probably the breadth of the whole mass of the North mountains, including Digby neck, will not be found to exceed, at most one thirtieth part of its whole length. From this circumstance, we may regard it rather in the light of an immense dyke, thrown up from beneath the sandstone through some vast and continuous rent, produced by the sudden eruptive upheaving of its strata, which allowed it to spread out laterally only to a very limited extent; and if theory is to be admitted at all, we know not how the origin of such a singularly disproportioned mass can be accounted for in any other way. Its regularity of outline, its continuity, and especially its almost exact linear direction, are against the notion of its being the ejected matter of *successive* eruptions, and warrant the opinion we have above expressed as to its origin. It offers a very striking exception to the remark made by Professor Daubeny, though his ingenious reasoning is strictly applicable to it in other respects, that "the more ancient volcanic rocks seem to form continuous strata, spreading more uniformly on every side over a large extent of country;" which he says is the case with the basalt of the Giant's Causeway, the toadstones of Derbyshire, the porphyries of Edinburgh, and the trachytes of Mont d'Or.* And we have reason to believe that, in the progress of discovery, this remark, although once apparently true, will meet with similar exceptions in other countries.

* See Professor Daubeny's Description of Active and Extinct Volcanoes, page 407.

Having finished our account of the trap rocks of the country, comprising a complete description of that formation, with the more important and curious mineral productions which it includes, and having suggested what appears to us the most obvious theory of their origin, which, derived from remarkable peculiarities of color, structure, and other appearances of contiguous strata, appears to account for those phenomena in a more satisfactory manner than any other, we shall now pass to the neighbouring strata of sandstone and shale, forming the moderately elevated and rounded hills of the county of Cumberland, and part of the county of Hants, and part of the districts of Colchester and Pictou.

It becomes necessary to describe this formation before speaking of the South mountains on account of its intimate connexions with the trap, which we have previously alluded to in describing the capes which project into the Basin of Mines.

The sandstone, constituting so large a portion of the Province of Nova Scotia, is of various appearance, differing greatly at different places. In the immediate vicinity of the trap, as at Cape Chignecto, Cape Sharp, and Swan's Creek it is of a dark brick-red color, and consists of irregularly rounded grains of quartz, usually very small, rarely exceeding the size of a pepper-corn, accompanied by minute spangles of mica, and united by an argillaceous cement, containing a large proportion of peroxide of iron. When in connexion with the trap, as before observed, the sandstone passes insensibly into the shale, or rather, the two form a compound in which the eye can distinguish no line of division, so completely are they blended. The shale varies greatly in color, and generally, like the sandstone, becomes red in the presence of the trap rocks, where it assumes a bright tile-red color, and when

exposed to the action of the waves, it becomes polished on the surface. This rock consists of thin folia of argillaceous slate, sometimes including a little mica, and is generally colored by oxide of iron. Comparatively remote from the trap, the shale assumes a grey, brown, or bluish-black color: more rarely it is spotted with green.

Near Diligence River, the shale is almost black, and appears to be colored by carburet of iron. It here includes a large bed of compact limestone, a section of which has been formed by the encroachments of the waters of the Basin of Mines. A little beyond Fox River, towards Cape D'Or, the sandstone, of a grey color, is seen to alternate with the strata of greyish-black shale, both of which are filled with relics of the vegetable kingdom of a former world. They are carbonized remains of various culmiferous plants, which are converted into a compact bituminous lignite. Portions of ensiform leaves resembling those of the Iris, or blue-flag, were here observed, lying between, and included within, the strata of sandstone.

The whole northern coast of the Basin of Mines, with the exception of the capes and islands of trap, before described, is composed of strata of sandstone and shale, alternating with each other, and presenting to the sea the edges of their strata, which are finely exhibited by this natural section. They do not attain a great elevation, rarely exceeding one hundred feet; and where exposed to the waves, the strata have suffered much from their violence, and the shale is always worn away, exhibiting the bold ridges of sandstone strata, contrasted with the deep furrows occasioned by its decay. The strata of these rocks are from a foot to four feet in thickness, and are alternately stratified with each other in great regularity; no limit being found to this alternation, we are unable

to say which rock is finally subordinate to the other. Near the village of Parsborough, the red shale appears to predominate, and constitutes a bed more than one hundred yards thick, which is beautifully spotted with green, and contains occasionally scattered crystals of yellow iron pyrites. East of this bed the sandstone appears in more powerful strata, and more than compensates for the thickness of the shale just mentioned. It forms a junction with the trap of Swan's Creek, where it includes beds of the carbonate and sulphate of lime, and where these two salts, so opposite in their nature, are seen actually in contact. The limestone is fragile and slaty, and contains scattered portions of coal; it is also sometimes bituminous. The gypsum is of the laminated and fibrous kind, the laminæ being sometimes more than a foot in length, and of a delicate flesh-color. But the laminated and crystallized gypsum is not so much sought for exportation as the amorphous varieties. At Tower Hill, twelve miles east of Parsborough, the sandstone again meets the trap, which forms but a small part of the precipitous summit, and has no amygdaloid in connexion with it. The united sandstone and shale, however, exhibit a most singular appearance, and, becoming vesicular, affect a curious imitation of amygdaloid, the place of which it occupies in relation to the trap. These rocks, forming the base of the precipice, are of a fine texture, and contain a large proportion of argillaceous matter, colored with peroxide of iron.

Passing beneath the trap in its immediate vicinity, it abounds with compressed and flattened spheroidal cavities, which, instead of the zeolites, are, when occupied, filled with rounded masses of gypsum, the mineral which usually occurs in this rock. These facts obviously tend to establish our theory of the origin of trap-tuff and amygdaloid, and render probable the explanation of these

phenomena, — that the quantity of trap present was inadequate to complete the process at this locality.

Beds of gypsum, of practical value, occur near the head of the Basin of Mines, in the vicinity of the Subenacadie River, where also occur large beds of limestone, containing the relics and impressions of marine shells. It is of an ash-grey color, and not very compact. In one specimen, a few crystals of galena were observed, scattered through a mass of petrified shells, which resemble the lituites described in Parkinson's Outlines of Oryctology, p. 165, and portrayed in plate vi, fig. 7, of the same work. Much larger and more valuable beds of gypsum occur in the county of Hants, and were first explored in the vicinity of Windsor about thirty years ago. It there forms a precipitous wall rising from the River St. Croix, and extending along its course as shown on the map. It still continues to furnish immense quantities, the greater part of which is sent to the United States.* This gypsum is of a bluish color, and is highly valued in the United States as a manure, although in its native country it does not appear to contribute in the least to the fertility of the soil; in fact, the hills entirely composed of gypsum, were not clothed with so luxuriant vegetation as those where this mineral was altogether wanting in the soil. The trap rocks by their decay furnish a far more productive soil, as is exhibited in the township of Cornwallis, justly entitled, the "Garden of Acadia," and along the whole extent of the base of the North mountains.

Gypsum also occurs abundantly in the county of Cumberland at the head of Chignecto Bay, and at several places along

* It is stated in Mr. Halliburton's History that for the last few years nearly one hundred thousand tons of this valuable mineral have been annually shipped to different parts of the United States.

the coast of the Gulf of St. Lawrence. One of the most extensive beds is on the banks of the Maran River, where the gypsum is of a bluish color and equal to any in the province.

The gypsum in the vicinity of Windsor, abounds in those conical or inverted funnel-shaped cavities, supposed to have originated in the solution of rock-salt (chloride of sodium), which has been imagined once to have occupied those spaces, though it is hard to learn on what evidence such a notion can be founded, as no rock-salt, or even traces of its existence have been discovered in this part of the province, or nearer to it than the county of Cumberland. The absence indeed, of anhydrous gypsum, which, according to Mr. Bakewell, usually accompanies the deposits of rock-salt, would rather show that this mineral never did exist here. In one of these caverns, about ten or fifteen years since, the skeleton of a human being, supposed from the relics of arrows found with it to have been one of the aboriginal inhabitants, was discovered in opening a gypsum quarry. It is presumed that this unfortunate individual, while pursuing his occupation of the chase, was precipited to the bottom of this frightful dungeon, and being confined by its inclined walls, was unable to escape. Thus incarcerated, he perished by hunger. His bones are still preserved at the College in Windsor, where they were politely shown to us by the Vice-President, the Rev. Mr. King, who gave the above account of them. No other remains, but those of this single human being, have been seen in these caverns, which, in truth, have excited little or no attention, and have never been examined with a view to determine whether, in some of them, the remains of animals both of living and *extinct* species, may not also have been entombed; if the former, by falling into them and perishing

from hunger, if the latter, perhaps by a more sudden extermination, like those mentioned by Professor Buckland. Had the bones referred to been found without the arrows, which afforded too true a history of their origin and the character of the lost individual to lead to further inquiry on the subject, it is probable that the discovery would have led to the thorough examination of the caves in search of other remains; and thus perhaps new facts might have been contributed to science, instead of which the caves, as we were told, are now covered with rubbish. It is a fact that the remains of animals whose living types are now unknown, have been found on Cape Breton, near the Wagamatcook River, where, we are told by Mr. Halliburton,* an enormous skull has been found, with molar teeth measuring eight inches by four across the crown or grinding surface, which is furrowed or divided into two rows of processes ten in number; a peculiarity in their structure which proves them not to have belonged to a carnivorous animal, and tends obviously to identify them with the grinders of the mammoth or fossil elephant discovered by our naturalists in South Carolina and Kentucky. The spot however we have, as yet, been unable to visit; but it certainly merits attention, in order, to discover, if possible, the remaining parts of the skeleton; a relic too valuable to science to remain only partially exhumed, since it may disclose to us the huge proportions of an animal whose remains, common perhaps in some of the Middle and Southern States, have never yet been seen in any of the Northern, or in either of the Canadas, to our knowledge.

On the banks of a small but romantic stream which empties itself into the St. Croix, called Montague River, a remarkably

* History of Nova Scotia, Vol. II. p. 243.

beautiful precipice of siliceous breccia passing into graywacke, presents itself to the traveller. It consists of angular fragments of quartz and felspar, rarely containing a few spangles of mica united without any apparent cement. The felspar, being of a flesh-red color, and forming a principal ingredient in the rock, gives it an appearance at a distance resembling red sandstone. The precipice is about sixty feet high, and rises from a base of the same rock making the bed of the stream, which has excavated numerous deep holes into the bottom, forming beautiful reservoirs of limpid water. The direction of the strata is N. E. and S. W. and the dip 10° to the northwest, forming a declivity down which the water rushes, and, falling from the broken strata, produces an agreeable effect. This place, adorned with overshadowing trees, is a favorite resort of the visitors of the Montague House, in its immediate vicinity.

We shall now advert to the sandstone of Cumberland, and describe the quarries of grindstones and the coal dsitrict of this region. The sandstone, where it emerges from beneath the trap at Cape D'Or, and where it comes in contact with it at Cape Chignecto, exhibits the red color noticed at other places in the vicinity of this rock, is more compact, and is destitute of organic remains. Leaving its Plutonic neighbour further up Cumberland Bay, it assumes a grey color. It alternates with, and passes into, a coarse conglomerate. At Apple River and the South Joggin it is quarried for grindstones and as a building material. This sandstone passes into the neighbouring Province of New Brunswick, forming the extensive grindstone quarries of Meringuin and Grindstone Islands, and is undoubtedly connected with the formation of this rock that includes the coal measures recently discovered on the Grand Lake in the interior parts of that province,

and has even been traced west of the River St. Johns. But no description of its characters, either fossil or mineral, has yet appeared; and as those places are beyond he limits of our observations, we must content ourselves with a brief notice of the quarries at the South Joggin and Apple River on the Nova Scotia shore.

At the former place the best grindstones are obtained, and wrought on the shore of Cumberland Bay. They are preferred when obtained at a considerable depth from the superficial strata, and are always taken at low water as deep as possible from the surface. Two or three layers are first removed which make inferior grindstones, and then the best ones are procured. In cutting the stones, the workmen frequently meet with hard rounded nodules which they call "bull's eyes," and which always condemn the stones as useless. They differ from the surrounding matrix only in being more compact and having less of the argillaceous basis, and breaking with a conchoidal fracture. The "bull's eyes" vary from one to ten inches in diameter, and sometimes they include a smaller spheroid as a nucleus within the larger.

Near the mouth of Apple River, grindstones are also quarried in the same manner as those of the South Joggin; they are not of so good a quality, but in other respects they are like those already described. The rock of which the grindstones are made consists of irregularly rounded grains of quartz, which are transparent and colorless or slightly tinged red, green, or blue, with a few spangles of mica and grains of felspar interpersed through the mass. The grains are usually minute, not often exceeding the size of a mustard seed. They are united by an argillaceous cement, which exists in a small proportion to the whole. This rock contains numerous remains of culmiferous plants, which

lie between the strata and are much compressed. They do not injure the grindstones unless many occur in the mass, which seldom happens, as they are mostly scattered diffusely through the strata. The fossils which occur in this sandstone, stamp it as a secondary rock, although it is evidently older than the trap rocks recumbent on it along the margin of the Basin of Mines.

A few miles southwest from the grindstone quarries at the South Joggin, a bed of bituminous coal exists in the sandstone, accompanied by shale. The bed is about five or six feet thick, and has been wrought to a small extent, but is now abandoned, and the shaft is filled with earth and rubbish. The coal contains an abundance of pyrites, which injures its quality as fuel. In the vicinity of this bed occur several smaller beds, one of which is covered by a stratum of bluish compact limestone, in the upper surface of which Dr. Lincoln observed fragments of shells resembling those of the common muscle (*Mytilus edulis ?*). Many of the vegetable fossils so common in the rocks of the coal series in other countries are found in great abundance here, imbedded in the sandstone, which dips at an angle of thirty degrees from the horizon, and includes the coal. Specimens of the *phytolithus verrucosus* were found by Dr. Lincoln, which exactly resemble those represented in the drawings accompanying Mr. Steinhauer's article on these fossils in the "American Philosophical Transactions."* Very good specimens of the fossil represented in Parkinson's "Organic Remains," (Vol. I. Pl. IX. fig. 1.) were also found. Substitutes of reeds and of plants resembling bamboos and rushes are likewise abundant. Some of the reeds are three or four inches in diameter and as many feet in length. They are

* New Series, Vol. I. Plate IV. fig. 1, 2, and 4.

invariably found traversing one or more of the strata at right angles with its layers. Some, especially the larger, are cylindrical; others are flattened and are generally coated externally with a layer of coal; some are smooth, others striated longitudinally as represented in Parkinson's "Organic Remains," (Pl. III. fig. 3.) Near the principal coal bed, Dr. Lincoln saw one segment of a trunk two feet long and twenty-five inches in diameter, and another about one foot long and eighteen or twenty inches in diameter. The external appearance of this petrifaction had led the grindstone-cutters to believe it to have been a hemlock tree *(Pinus canadensis.)* They say that a few years ago a large part of the trunk was standing erect in the cliff, with some of its branches attached to it.

Lignites are very abundant. Some specimens appear to have been trunks of trees, or succulent plants, of an enormous size, and they are found, not traversing the strata of the rocks like the stony casts of the reeds, but lying between them.

The Isthmus connecting Nova Scotia with New Brunswick, situated between Cumberland Basin and Bay Verte, is but twelve or fourteen miles wide, and, being composed of a friable decomposed sandstone, opposes a feeble resistance to the rushing waves of Cumberland Bay, where the tides rise to the height of sixty feet; while on the shores of Bay Verte they scarcely attain the elevation of eight or ten feet. One would suppose such frail barriers would give way before the pressure and violence of the conflicting tides. It is, however, a remarkable fact, that the same waves which cause so much devastation along the rock-bound coast of the Bay of Fundy, undermining and tumbling in confusion the lofty trap rocks, roll harmless against these shores, protected by the bold promontories of Cape Chignecto and Meringuin, depositing their spoils, taken

from the opposing rocks, quietly on the shores of Cumberland Basin, and thus fortifying the isthmus in its weakest point. The inhabitants assist the process, securing by dykes the soil deposited on their lands, and profitably use the bounties heaped at their doors by the tumultuous sea.

From the shores of Chignecto Bay the sandstone and slate, forming the county of Cumberland, extend to the waters of the Gulf of St. Lawrence on the north, and, stretching eastwardly towards the county of Sidney, constitute a part of the districts of Colchester and Pictou, and include all the coal measures of these districts. The interior of Cumberland county was not examined by ourselves, but we were credibly informed by intelligent persons residing there, of the extent of the sandstone district as represented on the geological map accompanying this paper.*

Salt springs have been found in various places near the shores of the Gulf of St. Lawrence. One of the most important exists near the river Philip. The brine of this spring contains a much larger proportion of salt than the water of the ocean, and it has been economically obtained by evaporation of the water. In the year 1811 large quantities were manufactured at this spring. A spring also occurs at Pictou, which was advantageously worked

* For the more extended eastern boundaries of this rock, as exhibited on this improved map of the country, we acknowledge ourselves indebted to the observations of Messrs. Smith and Brown of Pictou. The structure of the eastern parts of the Province having also been examined by these gentlemen, we gladly avail ourselves of this opportunity of referring the reader to their remarks contained in Volume II. of Mr. Halliburton's History of "Nova Scotia." Our observations, in the few instances in which they relate to the same localities, will be found to agree, if to this remark we make a single exception, to be considered in a subsequent part of this paper.

for salt on an extensive scale for several years, but is now abandoned, from what cause we are not informed; another is said to have been found on the River Souiac. No rock-salt has ever been found in the vicinity of these springs, where, if in any place, some more palpable traces of it might be expected; nor has the rock any perceptible salt taste. We must therefore refer the origin and the occurrence of these salt springs to such unexplained phenomena as are assigned to those in the western part of the state of New York, so ably discussed by Professor Eaton in his "Geological and Agricultural Survey of the District adjoining the Erie Canal." * The existence of salt springs in this formation indicates it to be identical with the Red Marle, or new red sandstone of Phillips and Conybeare, which includes the vast rock-salt mines of England and Poland; and also allies it to the saliferous rock of New York, described by Professor Eaton in the abovementioned "Geological Survey," and in the "American Journal of Science," † as existing on the banks of the Connecticut, and as supporting the Palisadoes on the Hudson river.

Pursuing this formation eastwardly in the direction of its strata, we meet with occasional beds of coal, not of any practical value, and offering no remarkable geological peculiarities. On the north bank of the West river, where the Kempt bridge crosses this stream, a bed of bituminous coal with lignites, about four or five inches wide, occurs in the cliff of sandstone, a section of which is formed by the bed of the river. At this place, which we mention on account of its vicinity to the road from Truro to Pictou, rendering it accessible to travellers, occur many of the relics of culmiferous plants before noticed at Cumberland mine.

* Part I. p. 109 et seq.

† Vol. XIV. p. 148.

Carriboo river, in the township of New Philadelphia, seven miles north of the flourishing town of Pictou, presents a field of great interest both to the mineralogist and the miner. On the banks of this stream, two miles from where it empties into the Gulf of St. Lawrence, occurs a bed of copper ore, included between the strata of sandstone passing into coarse conglomerate. It is associated with lignites of enormous size, which generally lie over the copper ore. The conglomerate consists of smooth rounded masses of quartz of various colors, siliceous slate, clay slate, and felspar, varying in size from that of a filbert to three or four inches in diameter; they are united by an argillaceous cement. The sandstone differs only in the size of the component ingredients, which diminish until they are scarcely distinguishable by the naked eye. These rocks rise from the river to the height of fifteen or twenty feet above its level, and form precipitous banks. The direction of the strata is nearly east and west, and the dip is about ten degrees to the north. The lignites are black, and some of them resemble common charcoal so much as to be easily mistaken for that substance. Some are fibrous, and exhibit evident traces of the organized structure of plants; others have lost every trace of organization, are compact without any fibrous structure, break with a conchoidal fracture, have a pitchy black color, and thus form the true jet of commerce, or the *lignite piciforme jayet* of M. Brongniart. This last variety take a good polish, and would admit of being wrought into jet ornaments inferior in no respect to those brought to this country from France. The lignite forms thin layers over masses of the copper ore, which sometimes presents very perfect substitutions or casts of culmiferous plants resembling the stalks of Indian corn *(zea mays.)*

The lignite sometimes contains minute, flattened crystals of

red oxide of copper, which are translucent and of a crimson red color.

Green and blue carbonates of copper occur, investing some of the lignites; and, filling interstices in the sandstone, they assume a botryoidal appearance. They also occur in delicate fibres, investing the masses of *vitreous copper ore* now to be described.

This valuable ore occurs in beds from two to four inches thick, which, covered with lignites, alternate with each other, the lowest bed being the thickest and most compact. It is of an iron-black color, with a slight tinge of lead-grey. It possesses a metallic lustre, and breaks with a conchoidal fracture. Some specimens are of a crystalline or granular structure, breaking so as to exhibit brilliant metalloidal surfaces; others are very compact, and break with a smooth surface. The specific gravity of the most compact variety is 5.7; but the granular varieties, more open in their texture, seldom exceed 4.8 or 5. It is sectile, and readily impressed by a smooth, blunt steel instrument; it therefore possesses a low degree of malleability, being extended under pressure without breaking. It receives a high polish, resembling in lustre and color the most highly polished steel, and retains this lustre unaltered by the action of the atmosphere. It is mixed occasionally with yellowish and a lighter grey pyrites, which is much harder and not sectile, and contains a smaller proportion of copper than of iron; but no specimen of this ore gives any traces of arsenic or antimony, when examined before the blowpipe, or when dissolved in nitro-muriatic acid and largely diluted with water. Nor does a solution in nitric acid give any precipitate when muriate of soda is added; and sulphuric acid throws down no precipitate; hence it does not contain any silver or lead. The nitric solution, tested

by aqua ammoniæ, became of a fine blue color, and, treated to excess of saturation, gave a brown precipitate of oxide of iron.

To determine the composition of the vitreous copper, similar trials were made, which discovered nothing but copper, sulphur, and iron. This ore was called by the miners from Cornwall, who were exploring the mine, grey-copper, (fahlerz of the Germans.) But according to an accurate analysis which we have made of this ore, it is to be considered as the vitreous copper (kupferglanzerz), which is more valuable than the grey-copper ore. We have taken for our model the analysis of the vitreous copper ore from Siberia, detailed in the celebrated Essays of Klaproth. As our results differ somewhat from those of this excellent analyst, and no source of fallacy can be discovered on repetition of the process, we shall give below an account of the method pursued, although it possesses no claim to originality, but was purposely conducted after the manner of this chemist. We are the more disposed to do this, as some of our readers may not have access to the work of Klaproth, which has become scarce, and may still wish to see the *modus operandi* exemplified.*

* Analysis. — A specimen of the copper ore was selected, having the specific gravity 5.7. It was sectile, possessing on the cut surface a brilliant metallic lustre, resembling polished steel, but more of a lead-grey appearance. It was carefully freed from the surrounding matrix and envelope of lignite, and reduced to powder.

A. Two hundred grains of this powder were introduced into a matrass, and pure muriatic acid affused upon it, which dissolved nothing, even when heated to boiling; showing that the metals do not exist in the state of oxides, but in a metallic state.

B. To the contents of the matrass while boiling, hot concentrated nitric acid was added by drops, which at each addition occasioned a violent effervescence, with the extrication of red fumes. The acid was added until it ceased to produce action. A flocculent greyish-white precipitate had formed on the surface of the fluid,

The sandstone, continuing its eastward course through the district of Pictou, approximates to the slate of the South moun-

which was the sulphur extricated from the ore. When cool, the contents of the matrass, being diluted with pure water, and carefully washed from its surface, were thrown on a filter of known weight. The precipitate collected on its surface, washed with dilute nitric acid, and afterwards with water, being dried, was found to weigh thirty eight grains. This was ignited in a crucible of platinum over an alchohol lamp, and burned away, leaving two grains of a dark grey powder, which was a portion of the ore that had escaped decomposition. This was treated with nitro-muriatic acid, and being dissolved by it, was added to the filtered solution. The sulphur then in two hundred grains amounts to thirty-six grains, or eighteen per cent.

C. The liquid which had passed the filter was of a bluish-green color, and transparent. It was divided into two equal quantities. In one portion a polished cylinder of iron was immersed, and in forty-eight hours the copper had precipitated upon it in a dendritic form. That it had entirely separated the copper was known by the solution ceasing to give a tarnish of copper to a polished steel instrument. The copper removed from the cylinder of iron, washed and dried rapidly to prevent oxidation, was found to weigh 79.5 grains.

D. The other half of the solution was treated with aqua ammoniæ to excess of saturation, when a muddy brown precipitate took place, which, when collected on a double filter of known weight, washed, dried, and ignited with a little wax in a platinum crucible, was reduced to the protoxide of iron attractable by the magnet, and weighed 3.4 grains, indicating 2.5 grains of metallic iron.

E. To determine whether the solution was equally divided, and to prove the correctness of the process C., the ammoniated solution was saturated and acidulated with sulphuric acid, and a plate of polished iron was immersed in it. The copper precipitated in a brilliant metallic coating, and when separated, washed, and dried, weighed with the loss of a trifling fraction, like the result of the former process, 79.5 grains.

This ore contains, then, in a hundred parts,

Copper, - - - - - - - - -	(C)	79.5
Sulphur, - - - - - - - - -	(B)	18.0
Iron, - - - - - - - - -	(D)	2.5
		100.0

tain range, which it meets in the township of Egerton, near the sources of Middle and East rivers. In the village of New Glasgow, there occur important beds of bituminous coal near East river, included between the strata of sandstone, and overlaid by a decayed, blackish shale. It contains remarkably perfect stony casts of culmiferous plants, which were shown to us by Mr. Blanchard of Truro. The coal is of a jet-black color, has a glossy appearance, and is highly charged with bitumen. It burns with a bright flame, and smokes much when first kindled. It appears to melt and cake like the Newcastle coal, and when completely on fire, after the bituminous matter is dissipated, it burns like coke.

There have been five or six shafts sunk into the coal strata, in different places, under the direction of Mr. Carr, who resides at this place; but at the time we visited them, these openings were partially filled with water, which prevented us from making any accurate examination of the beds of coal, and the associated rocky strata. The coal that had been thrown out was of a soft, friable nature, and would be soon ground to dust by friction in transporting it to any considerable distance. But preparations were then making, under the direction of two very intelligent and practical gentlemen of Pictou, Messrs. Smith and Brown, to explore this coal on a larger scale. We are now informed that the mining operations are carried on very extensively, and that coal of the first quality is obtained. It is shipped to the United States, where it is found well adapted for all the purposes for which other bituminous coal is employed in the various manufactories of the country.

About twelve miles northeast from the coal mines of New Glasgow, and eighteen miles from the town of Pictou, the sand-

stone and shale meet the transition clay slate of the South mountain range. But the immediate junction of these rocks was not discovered on account of the deep, unbroken soil which overlaid and concealed from view their respective strata. It is evident that the strata unite near this place, from the fact that their lines of bearing here intersect each other at an acute angle; the bearing of the clay slate being north, sixty degrees east, while that of the sandstone is directly east. The clay slate dipping at an angle of fifty or sixty degrees to the northwest, while the sandstone dips at angles of only ten or fifteen degrees to the north, clearly indicates the former rock to be of greater antiquity than the latter, which was before proved to be secondary from the fossils it contains. It evidently lies over the clay slate, and we regret that we were unable to discover a single spot from which the soil and gravel had been removed, so as to exhibit the connexion of the two rocks. Future explorers by traversing the forest, may perhaps find an outcropping somewhere along the line of their union, which will repay the labor of research, by illustrating their relations and comparative age.

Near this place, on the estate of Mr. Grant, a bed of brown and red hematite was discovered about twenty feet in width. It exhibits all the varieties of imitative form usually observed in this ore, and resembles many of the specimens of the hematite brought from the Salisbury mines in Connecticut. It is associated with grey oxide of manganese; which forms a considerable proportion of the bed, and is usually disseminated through the geodes of the hematite, in sheafs of radiating acicular fibres, or in distinct concretions, of which however none of the individuals possess determinable crystalline faces. It is also in more compact globular masses, which are granular, but without any tendency to a

crystalline structure. Its color is between lead and steel-grey, and it possesses a high metallic brilliancy emulating that of antimony-glanz, and is not tarnished by exposure to air and moisture; while the hematite, with which it is blended, or sometimes alternates in successive botryoidal coatings, has often become very rusty on its surface. Its color is the same, whether exhibited by its streak or ground to powder.*

The geodes in this hematite are also frequently occupied by crystals of arragonite, in six-sided prisms, and also sulphate of barytes in compressed or tabular crystals, usually of a pure white color, and but very loosely attached to the matrix; or they are sometimes completely isolated. Several masses of a foliated structure, composed entirely of this substance, were also found in the soil near "the brook." Whether the manganese, intermixed with this ore, will prove injurious to the iron in the operation of smelting it, is a question of importance to those who may be engaged in working it. It is certain that it must exert some injurious

* The common grey oxide of manganese has recently been divided by Mr. Haidinger into two new species. (Edinburgh Royal Society Transactions, Vol. XI.) The mineral above referred to by us, is evidently his pyrolusite, with which it agrees in its characters of hardness, color, streak, &c. and, what must not be overlooked, in its being associated with precisely the same ore of iron; an ore to which it is almost exclusively attached in other countries. The other species, called by him manganite, which is much harder, is often in distinct prismatic crystals, that exhibit a brownish-red streak, and is said by him to have been found in Nova Scotia, has not yet come under our notice there. We have it from the neighbouring Province of New Brunswick, in elongated rhombic prisms deeply striated, and in druses of acicular crystals, answering well to the characters which, according to this acute observer, give it undoubted claims to be considered a new species. Is it not possible that his specimen may have come from that Province, since he does not cite its precise locality?

influence in the smelting furnace, whether it combines chemically with the iron or not; for in consequence of its existing in the state of a peroxide of the metal, a large portion of heat and carbon must be taken up in the formation of carbonic acid, or carbonic oxide, by the union of the carbon and oxygen, and the iron, by losing any portion of the carbon it had previously taken up from the charcoal, is rendered of an inferior quality. The preparatory process of burning the ore might perhaps be resorted to with advantage. A bed of buff-colored limestone occurs in the sandstone, near the hematite locality, and will prove a valuable fluxing material to the ore, should it be worked in this part of the country. The limestone also forms beds in the sandstone at several other places, among which may be cited the Shubenacadie River, Gay River, and Pictou Island, as shown on the map. At the two last named places, it contains small but well characterized remains of the cornu ammonis, with crystals of argentiferous galena, arseniate of lead in minute crystals, and carbonate of iron, the latter filling the cavities of the fossil ammonites. It is cavernous in some places; and, according to Mr. Halliburton, a kind of grotto has been discovered in it near the East river of Pictou, about one hundred feet in length, and beautifully decorated by numerous stalactites depending from its roof.

Four miles southeast of this place a very important and extensive bed of iron ore exists, in the clay slate of the South mountains, which we shall describe after noticing generally the whole transition clay-slate formation of Nova Scotia, commencing at the eastern extremity of the district of Pictou, and extending west southwest to the opposite shore of the Province. This rock presents a larger extent of surface, than any other in the Province, forming nearly one half of the whole face of the country. It pre-

sents every where a uniform geological character; and containing fossil organic remains, belonging to the marine world alone, and some of them of the oldest kind, it must obviously, according to the common geological division, be regarded as transition rock,* and as having existed long before the neighbouring Plutonic rocks had emerged from the central regions of the earth. That this rock is older than the trap rocks we have additional evidence, derived from another source, which we shall state by and by, when our observations are directed more particularly to the iron-ore bed, which we have no hesitation in saying extends throuhg the whole clay slate formation. That it is newer than the granite will appear evident from reasons to be assigned.

The direction of the strata composing this formation is uniformly north, 60° east, dipping at an angle of 50° or 60° from the horizon. The color of the rock, on fracture, is black, greyish, or bluish-black. Its structure is slaty or foliated, frequently separating by a gentle blow into broad sheets, which are sufficiently smooth and compact to be employed for writing-slate. This is the case at Rawdon, where it is obtained for this purpose, and also extensively quarried for roofing-slate. In other places being less distinctly foliated, its tendency is to break into huge rhomboidal fragments, as it has natural seams both in the direction of, and at right angles with its stratification. This renders it a valuable building material as it forms convenient shapes for rearing walls of houses, for which purpose it is employed in many places.

The soil resulting from, and lying over this formation, is much inferior to that produced by the disintegration of the trap rocks

* The term *transition*, although objectionable in some respects, we have adopted for the want of a better; it certainly conveys what is very apparent, the *intermediate* character of the rock, to which it is applied in this paper.

of the North mountains, and the neighbouring sandstone; its vegetation being less luxuriant, and requiring for its culture greater labor from the husbandman. This is a fact which the traveller, in passing through the country, can scarcely fail to observe. The soil has been much improved of late years; and the present state of agriculture in Nova Scotia is much indebted to Mr. John Young, the author of a series of interesting and practical letters published in Halifax under the signature of "Agricola," to whose labors, we believe, the country is indebted also for many of its agricultural societies.

The continuity of the strata of this rock is interrupted in two places by dykes of trap porphyry, which, entering the rock nearly at right angles with its stratification, completely cut off or intercept the bed of iron ore, which is continuous and parallel with the strata. We shall notice these dykes more particularly in another place, as also the granite represented on the map in Annapolis county, which is undoubtedly subordinate to the clay slate, and all the other rocks in Nova Scotia.

The bed of iron ore alluded to, is apparently about sixteen feet wide, though, as it had not been explored at the time we visited it, we are unable to speak positively on this point. Its direction, like that of the strata in which it is included, is north 60° east; and it may be traced for some distance into the forest, until obscured by soil and under-brush. The ore on the surface, from which it may readily be detached, is usually of a compact structure, sometimes inclining to slaty. Its external color is brown and reddish-brown, but its streak and powder are deep red; consequently, it is in the state of peroxide of iron. It is destitute of magnetism and metallic brilliancy, and in these respects differs greatly from the ore in other parts of this bed, in another coun-

ty. Its specific gravity being 4.00 it contains by calculation according to Rinman's method, fifty per cent. of metal; a very near approximation to the truth, as proved on assaying the ore in a crucible, and duly allowing for the carbon combining with it in the process. It abounds with fossil remains; and some specimens, in which they are the most numerous, contain lime in the state of carbonate, readily effervescing with acids. It contains besides a portion of alumine and silex, which in smelting perform the function of a flux.

Among the fossils discovered in this ore, the most numerous are the tellenite, pectinite, and terebratulite. Those observed less frequently are small lenticular shells, resembling the nummulite, as figured in Parkinson's "Outlines of Oryctology," (Plate VI. fig. 5;) and also very distinct impressions of encrinites, which, instead of occurring in crylindrical columns as is ordinarily the case, are formed of a series of circular joints or vertebræ, that are smaller at one extremity than the other, so that the fossils assume a conical form. (See Parkinson's "Organic Remains," Vol. II. p. 164.) The old name of "Screw Stone" we found had been applied to these fossils by the people in the neighbourhood, who, struck with the singular appearance of these relics and those accompanying them, evincing, as they thought, a former life, had carefully preserved some of them, in the hope of perhaps learning something of their history. These fossils are not confined to the ore alone, but may be seen in almost every slate stone scattered through the adjoining fields; and should the ore at this place be explored to any extent, doubtless a far greater variety of these entombed relics will be brought to light, and furnish the collector with many rare productions of the ancient world.

Following the slate formation westerly, this ore-bed does not again show itself until it is seen on Nictau Mountain, in Annapolis county, as shown on the map; it being obscured between the two places by the unbroken forest, except that in a few spots fragments of it have been picked up, barely sufficient to prove its continuity from one locality to the other. At Nictau the width of the ore, at the surface, is but six feet and a few inches; but, increasing apparently as it deepens, it gives the promise of an immense supply of this valuable mineral. It is covered by a stratum of ferruginous soil about two feet thick, on removing which the surface of the ore-bed, being in some places quite smooth as if worn down by attrition, is seen curiously intersected by seams, some of which cross it transversely or nearly at right angles, and, when not open fissures, are filled up with a substance not unlike red ochre. They give the ore a tendency to separate into rhomboidal fragments, similar to those into which the slate itself often divides, and besides greatly facilitate the labor of raising it. The bed has been opened to the depth of eight or ten feet, and some hundred tons of the ore have been removed to the smelting furnace situated on the southern shore of Annapolis Basin.

The character of the ore at this place differs in some respects from that of the Pictou ore. From its very uniform slaty structure, it is more easily broken up; and it abounds to a much greater extent with the casts of marine shells, the calcareous parts of which, are sometimes still preserved. It also contains a larger proportion of iron, has a slight metallic lustre, and exerts magnetic influence upon the needle. But it is not a little singular that this ore-bed, although the grave of millions of once living shell-fish, the remains of which it exhibits in every part, should afford traces

of no other than bivalves, and of those belonging exclusively to the genus anomia. This however is the fact so far as we have examined it. Like many substitutions of this character, they exhibit with great precision and beauty the original external figure of the living shells. The slate also, when in immediate contact with the ore, exhibits the same remains, and it is not unusual to find one half of a shell moulded in it, while the other is firmly attached to the ore, which is thus proved to have been of nearly contemporaneous origin with that rock; or at least, by its union with it, it is proved to have been deposited before the latter had entirely consolidated, or while it was yet in a plastic state. In no other way can this union be satisfactorily explained; for it disproves at once any hypothesis founded on the supposed greater antiquity of the slate, according to which the two bodies should lie only in contact, without showing any marks of intimate union. That they are nearly contemporaneous, we have besides the further evidence derived from the fact, that the fossil shells are precisely the same in both. Their more intimate union, in some parts, we doubt not, may have been assisted by the heat attending the production of the neighbouring trap rocks, the effects of which, we think, are very apparent in another part of this ore-bed, where it very nearly approaches the trap. But of this subject, involving again the igneous origin of the trap, we shall presently speak more at large.

On ascending the highlands south of the falls on Nictau River, a rock was observed of a granular structure, of a greenish-grey color, and containing imbedded concretions of white felspar. It is evidently a part of a dyke of porphyry, as we have represented it on the map, intercepting the strata of slate and the ore-bed accompanying it, both of which it must cross nearly at right an-

gles, if it continues to any extent. But we were unable to discover the precise spot where the ore is crossed by it; a discovery, which, considering the nature of this dyke, might have disclosed some important facts. This spot, however, must be met with ere long by the miners, in the progress of opening the bed, as it is found most advantageous to remove the ore to the depth of but a few feet from the surface.

In the vicinity of this dyke, we observed several irregularly shaped masses of metalloidal diallage, which, when struck with the hammer, were sonorous, ringing with a sound not unlike that produced on striking a solid mass of metal. It is of a grey color, has an interwoven, laminated texture, and breaks with great difficulty into rough, splintery fragments, which reflect from the surfaces of their laminæ the metallic lustre peculiar to this sub-species. We also noticed several scattered masses of that variety of amygdaloid called toadstone, possessing the characteristic appearance of this rock from Derbyshire, and resembling that found at Brighton in Massachusetts by Godon, an accomplished French naturalist.*

From whence came these boulders and those of common trap that are now extensively spread over the southern parts of this Province, so distant from any rock to which they bear the least resemblance? We may venture to infer, without being chargeable with a disposition to support a mere visionary hypothesis, (for we believe it founded on data which must carry conviction to most minds,) that those of common trap and vesicular amygdaloid were derived from the trap-rock ledges of the North mountains, and transported hither by that great and sudden

* See his paper on the structure of Boston and vicinity, in Vol. III. of the Academy's Memoirs, page 127.

catastrophe which has left similar, but often far more striking, traces of its violence in other countries. And they not only afford us proof of the diluvial flood; they lead us, further, to believe that the overwhelming torrent swept across this peninsula nearly in a north and south direction; such being always the direction of these detached and drifted *débris* from the distant and parent ledges with which they claim a common origin. The boulders of granite also afford additional evidence of the same fact; for they are never met with on the *North mountains, which present nothing extraneous of any character*, but are abundantly scattered about in the opposite direction. If natives of the country, as they appear to be, they also must have originated from some part of the South mountain range, where the granite is now in place and forms beds to a very considerable extent, as may be seen on the map.

In the "Reliquiæ Diluvianæ," of Professor Buckland, we find the granite boulders of Nova Scotia cited among the many other proofs he has ably and ingeniously brought forward in support of the diluvial current. If to these boulders of granite, we now add those of the trap unknown to this author, or not mentioned by his informant (Sir Alexander Croke), we may safely conclude, in his own language, "that the present position of these fragments can be accounted for only by supposing them to have been drifted from the nearest granite [and trap] districts, by the same rush of waters that transported those mentioned by Dr. Bigsby, in the districts of Lake Huron and Lake Erie."* Of the other evidences mentioned by him, such as valleys of denudation, the furrows or parallel scratches upon the surfaces of rocks, and vast

* See the work of Professor Buckland, page 217. Also Dr. Bigsby's article in the Geological Transactions, New Series, Vol. I.

accumulations of sand and gravel, Nova Scotia, as far as we know, affords none; though such may reasonably be expected in a country like this, where the boulders so fully attest the occurrence of that event, which the enlightened labors of Professor Buckland, Cuvier, and others have taught us to regard as no other than that so briefly narrated in the Mosaic history. There are those, however, who, with the greatest reverence for the Scriptures, confidently assert, that the phenomena, usually referred to the Deluge of Noah, had in reality nothing to do with it, and must be accounted for on entirely different grounds. Among these Dr. McCulloch holds a high rank. He refers these phenomena to causes which have operated before, as well as since, the Deluge, and which are even now in operation; such as the bursting of lakes, the action of rivers, and wearing away of mountains. In the currents produced by the sudden elevation of strata, he remarks, we shall probably find the true causes of such alluvia (boulders &c.) as cannot be attributed to rivers and other existing causes, and have so often been attributed to the Deluge, which, he believes, was inadequate to produce any one of the effects ascribed to it.*

In the alluvium which forms the greater part of Aylesford township, and the valley between the two ranges of moun-

* See Dr. McCulloch's recently published system of Geology, Vol. II. The opinions of an observer so cautious and experienced are deserving of high consideration; but whether, in the present instance, they will lessen the high authority of the "Reliquiæ Diluvianæ," which contains the observations and concurring testimonies of so many different writers, is a question, which we leave to be determined by those who are thoroughly conversant with the phenomena on which it has arisen. It is for geologists on this continent to examine the supposed cases of diluvian action, and to see whether they can be explained consistently with the principles laid down by Dr. McCulloch.

tains extending from Minas Basin to the Basin of Annapolis, there occur very extensive beds of argillaceous iron ore. These are about two feet thick, consisting of concretions known usually as "shot ore." It is of a spongy, or vesicular appearance, and presents, to a great extent, the resinous lustre exhibited by the best varieties of bog ore. But, in some places, it is intermixed with the earthy phosphate of iron, or the substance to which Bergman attributed the cold short quality of the metal in its malleable state. It is however proved inadequate to explain the cold short quality of iron, not only from the impossibility of the acid escaping decomposition in the smelting-furnace and refinery, but also from the fact that ores containing no phosphorus are as liable as any to yield a metal of this quality.

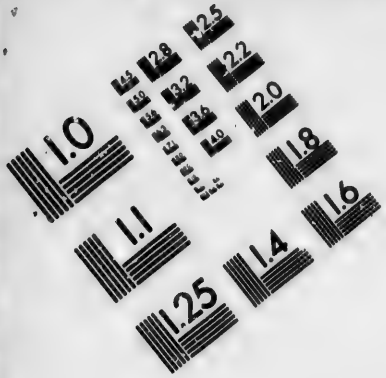
Leaving Nictau and the dyke of porphyry, the great bed of ore of the South mountain does not appear again, so far as the forest has been examined, until we reach the vicinity of Clement's, a distance of thirty miles. But the evidence of its intermediate continuity is such as to leave but little doubt on this point; for, in the bed of almost every brook or rivulet descending from the mountains, are to be found, to a greater or less extent, fragments of this ore, which contain the usual marine impressions, and which, at some time or other, must have been detached from the main body. Should the spirit of competition among iron manufacturers in Nova Scotia ever equal that which characterizes some quarters of the United States, it is believed that no part of this range will long remain unexplored, or fail to produce abundantly that article, on which depend so many other arts and manufactures.

Before alluding, particularly, to the iron mine at Clement's, we will offer some remarks on the granite formation of this country,

having already spoken of the boulders of this rock. This is the only rock in Nova Scotia having any claim to the title of primitive. It first appears along the South mountains, a few miles east from Bridgetown, generally in large detached masses, which are piled in confused heaps on their sides, or have been precipitated into the valley beneath. Between Bridgetown and the village of Annapolis, it occurs in place, and forms, for nearly the whole extent, the abrupt and barren mountains, which, having a rude outline, are contrasted with those composed entirely of slate, which present rounded and gently sloping sides. It also appears on the road from Annapolis to Clement's, in immense cubical blocks, which contain disseminated masses of chlorite and manganesian garnet. The latter is not distinctly crystallized, and being of a fragile nature, few interesting specimens were obtained. These are the only imbedded minerals known to exist in it, as it does not contain metalliferous compounds of any kind.

The component ingredients of this rock are not united in very uniform proportions; the mica, of a brilliant jet black, enters largely into its composition. The felspar is sometimes of a flesh-color, and the quartzy concretions are translucent and vitreous. The rock has a brecciated appearance, and includes masses of granite of a different nature from itself. These masses appear frequently in patches of a finer grain and darker color, than the surrounding granite, from which they differ only in this respect. The felspar of this granite is exceedingly prone to decay, and decomposes rapidly, on the exposed surface of the rock, insomuch that large quantities of angular fragments of the quartz are profusely scattered around, and constitute, by this *débris*, the first rudiments of the soil. The protruding angular fragments of

quartz give this rock a rough, forbidding aspect; and becoming loose in a few weeks, they dislodge any lichens which may have clung to them for support, and thus preserve a barren surface, defying all vegetation. The internal structure of this granite is firm and compact. It has a dark appearance, derived from the color of the mica, which is uniformly distributed through the mass. This rock would form an excellent building material, if the felspar was less prone to decomposition. This prevents its use in buildings, which are intended to last for a long time. We have before suggested, that this granite was subordinate or inferior to the clay-slate of the South mountains, and to all other rocks discovered in the Province. It here exhibits itself, protruding through the clay-slate. The line of junction was not however observed, as the covering of soil and underwood concealed their union. That there does exist a point of contact near this place, we cannot doubt; for a person may, in a few steps, pass from one formation to the other. The granite exhibits no appearance of stratification, from which we could estimate its direction; but there can be no doubt of its age being greater than that of the clay-slate, which it evidently supports, throughout its whole extent. That the granite is older than the clay-slate, appears from its containing no relics of organized beings, which occur in the latter, and prove it to belong to the transition formation. We do not however consider this granite as belonging to the oldest primitive, from the absence of all those metalliferous compounds and minerals which characterize more ancient formations; from its brecciated structure, and from its being in contact with transition rock. It probably belongs to what Werner calls the newest granite formation; a formation which is supposed to have been derived in part from the spoils of one still more ancient.



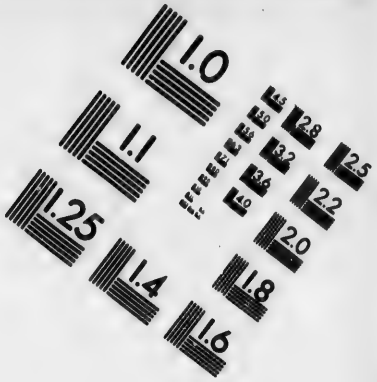
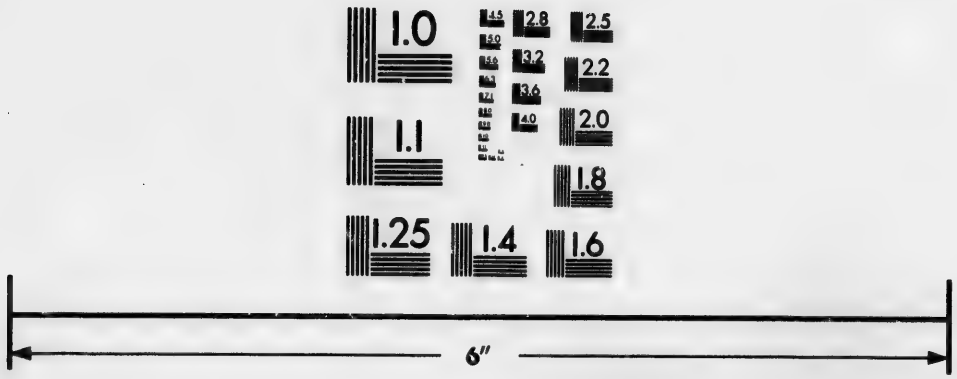
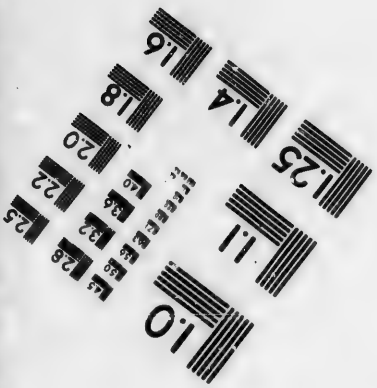
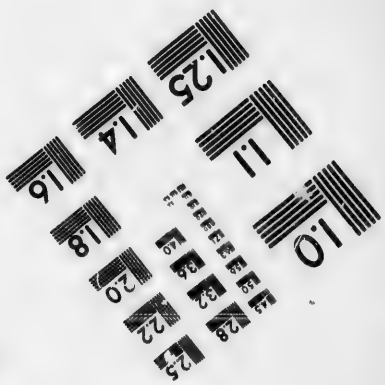


IMAGE EVALUATION TEST TARGET (MT-3)







Photographic Sciences Corporation

23 WEST MAIN STREET
WEBSTER, N.Y. 14580
(716) 872-4503

1.0
2.8
3.2
3.6
2.5
2.2
2.0
1.8
1.6
1.25
1.1
1.0

Speculative geologists may perhaps consider the relations of the bed of iron ore to this granite, as of some value in accounting for the origin of veins and beds in transition rocks. They would doubtless regard the protrusion of the granite from the central regions of our globe, as the cause of the disruption of the strata of clay-slate, which was thus raised from the bottom of the sea, bearing with it the spoils of the ocean. The layers would thus be broken, and their edges thrown up at an angle; and by the contraction of the subordinate rocks, the superior strata being fixed, or the protrusion having carried the rocks so far as to poise the strata in a perpendicular position, a chasm would be formed, into which the ore of iron was afterwards poured from above by a second submersion. But however this may have been, it is evident, from the facts already stated, that the origin of the ore and slate must have been very nearly contemporaneous.

The granite might have been, nevertheless, much older than the clay-slate, and constituted the base upon which it was deposited in a horizontal manner. The formation of rocks beneath the granite, by oxidation of the metallic bases of the earths discovered by the illustrious Davy, according to the views of that excellent geologist, Professor Daubeny, (if we do not misconceive them,) may have caused this protrusion of the granite against and through the overlying transition slate, which was thus raised from its horizontal position. The Wernerian and Huttonian theories thus united and modified, appear to account for so many facts in geology, that we could not refrain from adverting to them on the present occasion, and suggesting their application to American geology.

The granite, as we have said, is the only primitive rock known to exist in Nova Scotia. Besides being found on the South moun-

tains, we are credibly informed of its occurrence in the southern parts of the province, which we did not visit, and have therefore left colorless on the geological map accompanying this paper. On the authority of Messrs. Smith and Brown, we also add, as another locality of this rock, Cobequid mountain in Cumberland county, where, it is apparent, it must hold nearly the same relation to the sandstone, as it does to the slate in Annapolis county. But we must beg leave to differ very widely from these gentlemen in regard to the character of the rock, which, in different parts of the country, occurs with the clay-slate, and to which we find they have applied the term *primitive trap.** We think that we shall be able to show that this rock cannot be considered as trap in any form, and that its mineral characters clearly identify it with the quartz rock of McCulloch. Future investigations must determine whether the ore bed of the South mountains is any where cut off by the granite, or whether it continues uninterruptedly in the more elevated parts of the range which pass to the southward of the patch shown on the map, as we are in fact authorized to conclude from the direction of the ore bed at Clement's.

In the vicinity of Paradise river, a few miles from Bridgetown, gigantic crystals of smoky quartz (Cairngorm or Scottish topaz) are found among the granite boulders imbedded in the alluvium which forms the banks of the Annapolis river. One of these, found on the estate of Mr. Longley, weighed, we were told, more than one hundred pounds, and was remarkable for its symmetry of external figure, as well as the beauty and varied tints of its internal substance. The mass, we are sorry to say, was soon broken

* History of Nova Scotia, Vol. II. p. 417.

into fragments and disposed of, with the exception of a few of the smallest, which we had the good fortune to obtain. Some of these are nearly colorless and transparent, some are of a straw-yellow color, while others are of a smoky shade, passing into clove-brown. We were also fortunate enough to obtain from this place a perfect crystal, singular for its size and beauty, though smaller than the one just mentioned. Its weight is ninety pounds; it measures nineteen inches from the point of its pyramidal termination to its base, which is twelve inches in diameter, and has adhering to it grains of quartz and felspar, which indicate its former connexion with the granite, in a cavity of which it was probably formed. Its six lateral planes are nine inches in length to its acuminating planes, one of which, being unduly extended, nearly obliterates the two adjoining ones, and is twelve inches in length. This crystal presents, within, the richest shades of color, from light topaz and straw-yellow, through clove-brown, into a dark and almost opake smoky color. It is covered externally by a thin incrustation of common quartz, which, on being cleaved off, lays open numerous dark and brilliant prisms of schorl, some of which do not exceed in diameter the thickness of a hair, and are nearly transparent, while others are the sixteenth of an inch in thickness and three inches long. These slender prisms lie upon the surface of the crystal, or penetrate deeply into its substance, and render it an object of still greater interest. This remarkable crystal, though ordinarily opake, yet, under the influence of strong transmitted light, has its whole interior lit up into a beautifully transparent mass, reflecting the colors we have mentioned, and is altogether the noblest production which the country has afforded us; it is equalled only by the rarest of the rock-crystals found in the Alps and in Siberia.

Having thus far described the appearances and productions of the South mountains, we shall now advert to the ore-bed at Clement's, the last place along this range where it is known to appear. This bed is three miles from the mouth of Moose river; and, several extensive openings having been made into it, during the past season, from which many hundred tons of the ore have been removed, peculiar facilities are afforded for its examination. Its width considerably exceeds that of the Nictau bed, and perhaps ten feet may be assigned as its average; but from the intimate union of the ore with the contiguous slate, it is very difficult to discover the line of separation between the one and the other. In this respect it differs very materially from the ore of Nictau, where, to a much greater extent, the walls of the bed are distinctly presented. By the assistance of a compass, this ore may be traced for the distance of two miles, towards Bear river, so powerful is its magnetic influence on the needle. Indeed, land surveyors are more or less perplexed by its influence, while traversing the forests in different parts of this range, and these evidences are in support of the continuity of this bed from New Glasgow to Clement's.

This ore is compact or fine granular, of a bluish-grey or steel-grey color, and possesses a glistening metallic lustre. When reduced to powder, its color is similar. It is highly magnetic, strongly affecting the needle, as we have before observed, and is in fact the magnetic oxide of iron, or exists in the state of the protoxide of the metal, combined with lime, alumina, and silex. Its specific gravity is 4·5; exceeding that of the Pictou or Nictau ore, and it yields by fusion in the assay-furnace, sixty-five per cent. of soft cast-iron. But when reduced in the smelting-furnace, it has hitherto yielded less, owing to its ad-

mixture with the slate, from which it has been difficult to separate it. The cast iron obtained from this ore, is of good quality for strength and softness, while that of a harder nature, containing less carbon, is readily converted into malleable iron, which, to give it the praise it deserves, is equal to the best of this description made in the United States. The pure iron has also been converted into blistered steel, which, on trial, was found equally useful for the purposes to which the foreign article had been applied.*

The fossil remains contained in this ore are not so numerous as at either of the localities before cited. But, besides their impressions, we have here presented more interesting traces of them, which strongly indicate the effects of heat both upon their fleshy and crustaceous parts, in decomposing and converting them into the substances which are now presented in the ore. But we shall allude to this more particularly, after stating the fossils which were recognised. They are terebratulites, ammonites, tellenites, encrinites, and trilobites. Of the last curious and, in Nova Scotia, hitherto unobserved fossil, supposed to have been originally a crustaceous insect, we obtained the remains of one, two and a half inches in length. It presents a series of transverse joints, divided vertically into three lobes, the central one of which is more prominent than either of the other two, and has nearly the width of them both. They terminate at the lower part of the fossil, without showing the caudal projection observed in some species. The matrix, to which this fossil is attached, is a very compact mass of slate, passing on one side into magnetic iron

* It is to be regretted that the Iron establishment erected in the vicinity of the iron mine at Clement's in 1826, has since ceased its operations, as the country is now obliged to look to other quarters for the supply of an article which her own hills would yield her in an abundance almost unknown to any other.

ore. It is probable that remains of this fossil, much larger than this, will yet be met with in the slate, or in its included beds of transition limestone; as rocks similar to these have hitherto furnished the most remarkable that have occurred in Europe, some of which, found in the slate rocks of France, are, according to Professor Bakewell, seven inches in length.* They are found also of of equal size and in great perfection at Trenton Falls; and it is remarked by Professor Silliman that "some of them seem almost looking out of the black limestone rock, as if still animated."† Those found in the Dudley limestone, according to Parkinson, rarely exceed three inches in length.

In breaking masses of this ore, the fracture frequently crosses the fossils, and lays open their inner surfaces, which are often covered by a very thin and brilliant, bluish-green, botryoidal crust of the phosphate of iron. They also present this substance crystallized, in beautiful divergent plates, or laminæ, which are translucent and of a bluish-green color; also lamellar sulphate of lime shooting through the cavities from one side to the other. In some cases, the cavities, left in the ore by the decomposition of the internal part of the fossil, are entirely filled up with a yellow friable carbonate of iron, having, intermixed with it, a few bluish spots of the phosphate; at other times the crustaceous parts of the fossil are converted into carbonate of iron, which shows, distinctly, the original appearance of the shelly covering. In fact, in almost every fossil met with in this ore, we have one or both of these metallic salts, produced by the combination of its constituent principles, carbonic and phosphoric acids, with the

* Introduction to Geology, p. 27.

† See note on page 48 of his "Outline," appended to his edition of Bakewell's Introduction.

surrounding iron, assisted, as we have before ventured to say, by heat.

The existence of the sulphate of lime in the ore, although it is no direct proof of the action of heat upon it, yet has a bearing on the case. For it can hardly be overlooked, that the sulphur, which was at first united with pyrites of which there are yet traces in the ore, has, by its decomposition and passage into sulphuric acid, united with the lime of the shells, and thus given rise to the sulphate under the form we have described; leaving the iron of the pyrites behind, as we find it, in a yellow oxide. This process, we are aware, might have taken place, as it does take place, without much heat; but all the attending phenomena are such, in the present case, as to leave but little doubt in our minds, that heat was the agent employed. But, in addition to these, we have other arguments in support of these views, which, to some, may appear of a more positive character than those already adduced. It is well known that iron is deposited from an aqueous solution only in the state of the peroxide, and that its ores, in such cases, are never of a great specific gravity, and always void of magnetism. Now the aqueous origin of the ore in question, is evinced by the presence of marine exuviæ in every part of it; yet, in some places, even where the fossil remains are the most numerous, this ore has acquired the character of the magnetic oxide, and is no longer a peroxide. How then is this to be explained? how is it that the ore assumes such totally different characters in different parts of the same bed? that of Pictou being in the state of peroxide, as it was originally deposited from an aqueous solution, and that of Clement's in the state of the magnetic or protoxide. We conceive it undeniable, that this great change is to be ascribed to the heat attending the production of the trap rocks of the North moun-

tains, rendering the ore at Clement's, in their immediate vicinity, strongly magnetic by driving off a portion of its oxygen; while that at Pictou, more remotely situated, was not sensibly affected by its influence, but retains its full quantity of oxygen, is comparatively light, and is without magnetism. Besides, by this theory we are enabled to account for the existence of so large a quantity of carbonate of lime in the latter ore, the heat not having been sufficient to drive off the carbonic acid from the fossil shells contained in it. The superior compactness of the former, its greater specific gravity, and more intimate union with the adjoining slate, from which, in many places, it is difficult to discover any line of separation, are in confirmation of the theory which we venture to offer, thus supported, to the consideration of our readers; assured as we are, that should any of them be induced to pass over the same ground, and examine for themselves the evidences on which it is founded, they would not be disposed to differ much from us, if indeed they were not fully brought over to the same views. It affords new proof of the igneous origin of the trap rocks on which it wholly depends; and it is thus, we think, by amalgamating the rival theories of Werner and Hutton, that just conclusions can be formed, of the geological nature of this country, and the relation which the rocks of aqueous deposition bear to those of igneous origin.

The clay-slate forming the banks of Bear river, near its mouth, contains beds of iron pyrites, of a compact, amorphous character, well suited for the manufacture of copperas. In fact, where this mineral is freely exposed to air and moisture, the sulphate of iron forms spontaneously, and covers this rock with an efflorescent incrustation. The hepatic variety also occurs with it, and, extending through the rock to some distance from the

river, exhales in sultry weather, an odor, which cannot fail to apprize the inhabitants of its existence.

About four miles from Bear river, in the vicinity of a place known as "The Joggins," the clay-slate of the South mountains is intersected by another dyke of porphyry, which is here presented, forming the sides of a deep recess or valley, but a few yards from the main road to Digby. It enters the strata nearly at the same angle with the dyke, before mentioned, on Nictau mountain; and, like that, its actual connexion with the neighbouring slate being entirely hidden from observation, we were unable to determine its extent, or its more approximate relations to that rock. The base of this porphyry is a greyish-black trap, of a fine-grained texture, and compact. The imbedded granular concretions of felspar, of a pure white color, are very numerous. Though, for the most part, no regularity of form is discernible in them, sometimes distinct parallelograms of white felspar may be observed. The rock is thus rendered more distinctly porphyritic than that of Nictau.

We shall not attempt to discuss the origin of the dykes which thus intersect the strata of clay-slate; for the theory applied to all other dykes of similar character, is equally applicable to these. They are doubtless of an origin posterior to the clay-slate, and now occupy the immense fissures left by the contraction or solidification of the adjoining transition rock, including the great ore-bed; and have proceeded from, or are coeval with, the trap rocks of the neighbouring North mountains. Should the dyke at this place extend for any considerable distance into the high land, it will be found most probably to intersect the great ore-bed, which, from the direction of the latter near Bear river, must take place nearly two miles south of the valley. Whether the intersection does

actually take place, we are however unable to say; as from the very imperfect examinations that have been made below Bear river, the ore has not yet been observed in place; but from the magnetic needle being affected in this quarter as sensibly as between Clement's and Nictau, this supposition is rendered extremely probable, if, indeed, it is not confirmed by the discovery of masses of this ore in different parts of the high lands that stretch towards lake St. Mary's, which forms the western termination of the clay slate and the interstratified quartz rock. (See the map). Of the nature of the rock composing this cape we were in doubt, not having been able to visit it in 1827. For this reason, it was left uncolored on the map accompanying our remarks in Professor Silliman's "American Journal of Science," though we were correctly informed of the extent of the slate as far as it was exhibited by the coloring on that map. From a view given of it in Des Barres' "Atlantic Neptune," to which we have already referred the reader for several sketches of the scenery of Nova Scotia, we were led to expect the occurrence of columnar trap upon it; and the opportunity which it might thus afford us of witnessing the actual juxtaposition of this rock with the transition slate, a phenomenon for which we had hitherto looked in vain, was one which we could not well pass over unimproved. But on approaching the cape, which is fronted by a cliff of only about eighty feet, we soon found ourselves deceived by Des Barres' sketch, which, indeed, bore so rude a resemblance to the actual appearance of this spot, that we were led to believe it had been intended to represent some other of far greater height and magnitude. For instead of the oblique and irregular lines, that would alone have given the dip or inclined stratification of the *slate* composing the cliff, we have vertical and horizontal lines, that, in

truth, represent nothing but a vast *façade* of columnar trap. It is possible that the cape, at the time this sketch of it was taken, was much higher than it is at present; a change, which, if we consider the lapse of sixty years, and take into account also the destructive action of the sea, which in other places effects changes as great in one twentieth part of that time, cannot certainly be thought very remarkable. But the exact features of the spot must then have been strangely overlooked by the artist; for if he had correctly copied them, his picture could have never led to the error of supposing its composition to be of trap instead of slate.

No trap rock, in any form, occurs on the southern shore of St. Mary's Bay; even the dykes that occasionally penetrate the slate of the South mountains, and the drifted masses strewed over their surface, are here entirely wanting; and, if we except these, no indications of it occur in any part of Nova Scotia beyond the confines of the North mountain range. Its occurrence on the Island of Cape Breton has been barely mentioned by Messrs. Smith and Brown; and we regret that these gentlemen have not been able to give us some details respecting it. It may indeed be looked for wherever the sandstone prevails, as these two rocks are commonly associated.

The coast, of which we are now speaking, consists of slate, occasionally presenting, among its water-worn cliffs, interesting sections of quartz rock and beds of transition limestone. But the quartz rock of this place has not the usual compact, homogeneous character of that (soon to be mentioned) around Halifax, where it appears in more powerful strata, and, from its power of more effectually resisting the elements, stands up above the slate in prominent ridges, suggesting to the observer the appearance of

basaltic walls. It seems here more properly a fine fragmentary rock, consisting of granular quartz and felspar, united with grains of serpentine of a dirty green color, and having a saponaceous feel. It is traversed by narrow seams of fibrous asbestus, a mineral hitherto unobserved in this Province. But in a few places, becoming finer grained and compact, it passes into the slate as at other localities. Although, in containing the serpentine, it differs from the quartz rock near Halifax (the effect of certain local and accidental causes), it possesses, in common with this, the general structure and composition of the quartz rock of Scotland, so ably illustrated by Dr. McCulloch, according to whom it is sometimes met with in the Highlands of Scotland in a fragmentary form similar to this. It is not however, in this country, geologically associated with those rocks of the primary series, with which, according to that writer, it traverses different parts of Scotland; but, as it is *mineralogically* the same rock as the Scottish aggregate, it is obvious that the same title should be applied to it, although, contrary to the systems, it may place this rock among the formations of a later epoch, to which, in fact, the recent discoveries of distinguished geologists have shown it to belong; as, according to M. De la Beche, it occurs with argillaceous slate, containing fossils, in France; and it is even described, by Humboldt, as a secondary rock in the Andes of Peru, where it is extensively interposed in a formation of alpine limestone with fossil shells.* Its occurrence, in Nova Scotia, in intimate connexion with slate, containing the remains of the trilobite, a crustaceous insect, hitherto found only in the oldest transition rocks, proves it a more recent formation, but allows us

* Baron Humboldt's Essay on the Superposition of Rocks in both Hemispheres. p. 296.

to class it posterior only to the granite, on which it in fact immediately reposes, but with which it is never known to alternate. The slate and quartz rock were observed to extend round Cape St. Mary's for several miles towards Yarmouth; they probably form most of the coast from thence towards Cape Sable. We are, however, unable to speak positively on this point, from not having extended our examinations so far; but, from the information we have received, we are led to believe that it forms the whole western coast of the Province, interrupted only by the granite, which occasionally rises through it in the interior. The white banks, alluded to in Des Barres' work, are doubtless the quartz rock; and the white sand, also spoken of in the same work, is probably its disintegrated *débris*, formed and thrown up by the sea.* But we choose to leave, for the present, this part of the geological map uncolored, in the hope of seeing it filled up by the observations of others, or our own, which may hereafter be renewed in this region and extended perhaps to some remoter parts of it.

With the exception of the limestone referred to, veins of quartz sometimes crystallized, and occasional disseminations of

* Sable Island, which has proved so often a scene of shipwreck and desolation to mariners, is said to be formed wholly of this frail material, which is so light as to be carried about and drifted into new shoals by the wind and sea of almost every tempest. The island is very low; and, although but a little more than a mile wide, it is said to extend thirty miles in length. It is remarked by Mr. Halliburton, that "those who have not personally witnessed the effect of a storm upon this place, can form no adequate idea of its horrors. The reverberated thunder of the sea, when it strikes this attenuated line of sand, on a front of thirty miles, is truly appalling; and the vibration of the island under its mighty pressure, seems to indicate that it will separate and be borne away into the ocean." History of Nova Scotia, Vol. II. page 226.

iron pyrites, this coast, so far as we have traced it, presents nothing of mineralogical interest; yet the lover of the picturesque will be delighted with its scenery, which, although wanting, it is true, the majestic outline of the opposite coast, is more agreeably diversified by the alternations of different rocks, the variable manner in which the strata of slate are seen to run, and the deep glens that have been formed by the sea between their protruding edges. Of one of these spots, we find a view in the "Atlantic Neptune," showing the limestone caverned out by the sea.

The quartz rock before alluded to, is the only rock in Nova Scotia, of which we have omitted to mention the mineralogical characters. It is represented on the map as alternating with the clay-slate, and constituting strata of great dimensions. This is not strictly true to nature, for it alternates so frequently, as to render it impossible to give an exact view of its arrangement; but the proportion of this rock to the slate is correctly shown, by thus collecting the numerous narrow beds of it into a few large divisions. It occupies but a small part of the country. It is composed, as its name indicates, of siliceous matter, or quartz, which is fine granular, but more frequently compact, and breaks, not unusually, with a conchoidal fracture. It is sometimes white, and its grains are transparent; but it generally has a greyish or bluish tint, arising, apparently, from admixture with the contiguous slate, with which it is doubtless coëval. It frequently passes into flinty or siliceous slate, and is sometimes so intimately blended with the argillite into which it passes, that the eye cannot distinguish where the one begins or the other terminates. The layers of siliceous slate are often separated by thin folia of argillaceous slate, while the true quartz rock possesses no stratified appearance, and never separates into layers like the slate.

But, in a few instances, it loses entirely its compact and homogeneous appearance, and becomes a fragmentary compound similar to that already mentioned on the shore of St. Mary's Bay, excepting that it wants the greenish serpentine observed only at that place. One of the beds of quartz rock runs fifteen miles north of Halifax; two cross Bedford Basin; and the fourth forms a part of the Peninsula included between Margaret's Bay and Halifax harbour, where it presents itself to the ocean, and opposes an unyielding barrier against its mighty waves. It is not known how far these beds extend into the interior; but it is probable that they are continuous with the strata of slate, and are connected with the quartz rock on the shore of St. Mary's Bay.

It will appear evident we think, even setting aside its mineral composition, which alone is sufficient to determine its true character, that this rock can have no claims to the title of trap, whether considered as secondary or primitive; for, by its stratification with and passage into the transition clay-slate, it is proved to be contemporaneous with that rock, the strata of which it is never known to cross in dykes, as is ordinarily the case with trap rocks. Certainly the term *primitive*, which we find applied to it in the work we have alluded to, is peculiarly unfortunate. We mention this, in the present instance, in order to set forth more plainly our reasons for having applied the term *quartz rock* to the aggregate in question, and, if possible, to avoid the charge of having mistaken its true character. These reasons, we trust, will be sufficient to excuse us, in the minds of the gentlemen who drew up those remarks, from any wish of calling in question, unnecessarily, the accuracy of their observations, as we assure them that truth on the subject is our only aim, even if it come from a source that should expose the fallacy of our own views. The quartz rock, as we

have said, occupies but a small part of the country, being met with principally in the township of Halifax, where it constitutes the dreary and barren hills which surround that city, and which have falsely been considered fair specimens of the soil of Nova Scotia. From the nature of this rock, that part of the country, in which it predominates, must for ages remain sterile; as this flinty aggregate obdurately resists the action of the elements, and will require a long period for a decomposition of sufficient soil to reward the labors of the agriculturist; and this soil, from its nature, will never advantageously compare with the rich loam of the valley of Annapolis, or the garden of Acadia, Cornwallis, which are more favored by nature in this respect. Halifax, fortunately, is not dependent upon her soil to "yield her bread"; but, situated at the head of one of the most beautiful harbours in the world, with the romantic Bedford Basin in the rear, she possesses commercial advantages, to which those of no other place in the country can be compared, and is fully compensated for the imperfection of her soil, which, collected in the valleys, suffices to produce the garden vegetables for the city.

The traveller proceeding from the United States to Halifax, who is desirous of studying the principal rock formations described in this paper, can easily arrange his route so as to examine the structure of the country. If he goes by the way of St. Johns, (N. B.) and takes the steam-boat to Annapolis, he may examine to advantage the trap rocks of the North mountains, and the clay-slate of the South mountains, in his journey along the valley of the Annapolis river, in which he will travel between these two ranges to Windsor; and then cross the South mountains, the border of the sandstone and the quartz rock formation, to Halifax. From Halifax, he may shape his course eastwardly to Pictou, and

comprise in his observations the coal, iron, and copper mines, with the other interesting localities of that district.* Returning through Windsor, he may then take passage in one of the packets which statedly ply between that place and St. Johns, in which he will pass beneath the lofty portals of Cape Blomidon and Cape D'Or, and within near view of the high and picturesque Island situated off that coast. The readiness evinced by the masters of these packets, to aid the objects of travellers, will enable thm, on suitable occasions, to pass a short time in gathering up some of the many rare and beautiful productions that are scattered along this coast. But in order to bestow upon it the attention which it deserves, no method will be found so convenient and efficient, as that of chartering a vessel properly furnished for the tour, and large enough to admit of storing away the extensive collections of objects that may be obtained. This method was pursued by ourselves with great advantage in our last excursion to the Peninsula, and is one which our experience enables us to recommend to others as decidedly the easiest and most likely to be successful. A small boat, without sails, will also be found a useful auxiliary, by which access may be had to many places along the coast, where the water would be too shallow to allow a larger craft to ride in safety, or where such a vessel

* At the Provincial Academy of Pictou, there has been collected, and scientifically arranged under the direction of Dr. McCulloch, the principal of the institution, a very fine museum of natural history, particularly of native birds and insects, in which department this country appears quite similar to the United States, if we except, perhaps, the greater number of aquatic birds. The collection was politely shown us by Dr. McKinlay, one of the trustees and lecturers of the institution, and a clergyman of the place, to whom, for this and other acts of kindness, we would here express our obligations.

would be in the greatest danger of being driven upon the shore by the sudden and violent gales that spring up in this region, or of being hurled among the broken ledges by the tides and currents that rush impetuously along the coast, and leave only here and there a spot of real security, sheltered by some bold projecting ridge of rock.

In treating of the Geology of this province we have perhaps exceeded the limits within which, it may be said, we should have confined ourselves. But as our object has been to describe facts as they exist in nature, and also to point out, in some instances, the *rationale* of the more remarkable phenomena observed, it was found impossible to shorten the paper materially, without omitting parts which either had a necessary connexion with the whole, or which, in themselves, seemed too important not to have some brief consideration. Our object, too, has been to describe the structure and productions of the country in such a manner as would be most useful to those who may succeed us in exploring it; and in doing this, we have often cited several localities of the same substance, as it presented itself under some new form or variety, and have thus been led occasionally into a minuteness of detail which, though it has lengthened out our remarks, has given greater completeness to the whole. Among the numerous localities of mineral substances particularized in this paper, probably few will be found to have lost much of their interest since they were examined by us, while many of them will doubtless be found to have acquired much new interest by the changes they may have suffered in the mean time, and by the substances which these changes may have brought to light.*

* It may be well to state as a curious fact in this place, that no traces of the mineral known as prehnite have appeared in our examinations of the trap rocks of

Theories which are generally known and adopted, we have merely alluded to *en passant;* but when appearances justified it, we have advanced opinions, some of which are perhaps novel, although they are the legitimate inferences from the facts discovered in our investigations, which were carefully made, and the results recorded on the spot where they were observed. Some errors will probably be found in our statements, such as must unavoidably occur in an account of the geology of an unexplored country, where there are but few of those conveniences, which abound in our own, to facilitate researches into its physical structure. In the main, however, we trust that they will be found correct, although some omissions will doubtless be discovered, and the boundaries of the rock formations may not always have been exactly portrayed. This was a necessary consequence of the obscurity occasioned by the uniform covering of soil which exists in the interior, and which, although it enriches the country in an agricultural point of view, greatly embarrasses researches into its geology. The sea-coast, denuded by the action of the waves, exhibits the most satisfactory views of its rock formations; and when defeated in our search for the outcroppings of strata in the interior, we scarcely ever failed in obtaining a view of them somewhere along the extensive coast of the Province. The simplicity and remarkable regularity in geological structure exhibited in Nova Scotia, cannot fail to excite the admiration of every

Nova Scotia; although this mineral, accompanied by nearly the same substances that have been described in this paper, is abundant in the trap rocks of most other regions, and is never, we believe, wholly absent from any of them, when they occur to any considerable extent. And we are far from believing that it will not yet be met with when the rocks of Nova Scotia shall have been more minutely explored in search of it, and add another species to the interesting suite of substances which this country has already afforded.

geologist, who may examine that region, how much so ever he may disagree with us in our theoretical deductions.

We have purposely omitted, as being entirely foreign to the object of this paper, any references to the history and geography of the country, excepting in a few cases, where they could hardly be avoided in designating particular localities, and in assisting the traveller in finding such as were the objects of our examination. For much valuable information in relation to these subjects, as well as to the general statistics and topography of the country, we take great pleasure in referring our readers to Mr. Halliburton's "History of Nova Scotia," published at Halifax in 1829.

List of the Minerals of Nova Scotia, comprising such as are described in the preceding Paper, principally arranged, as to Species, Subspecies, and Varieties, according to the "Tabular View" in the System of Mineralogy by Professor Cleaveland.

SPECIES.	SUBSPECIES.	VARIETIES.
Sulphate of Barytes.		
		lamellar and granular.
Carbonate of Lime.		compact and crystallized.
	Calcareous Spar.	
		crystallized and lamellar.
		Dog-tooth spar.
		Stalactite.
		hemitropic.
	granular	
	magnesian	
		crystallized. Rhomb-spar.
	Brown Spar.	
	bituminous	
		Calcareous Sinter.
Arragonite.		
		crystallized.
Phosphate of Lime.		
		Asparagus stone.
Sulphate of Lime.		
	Selenite.	
		massive.
		lamellar.
	Gypsum.	
		fibrous, granular, compact, snowy, and stellated.

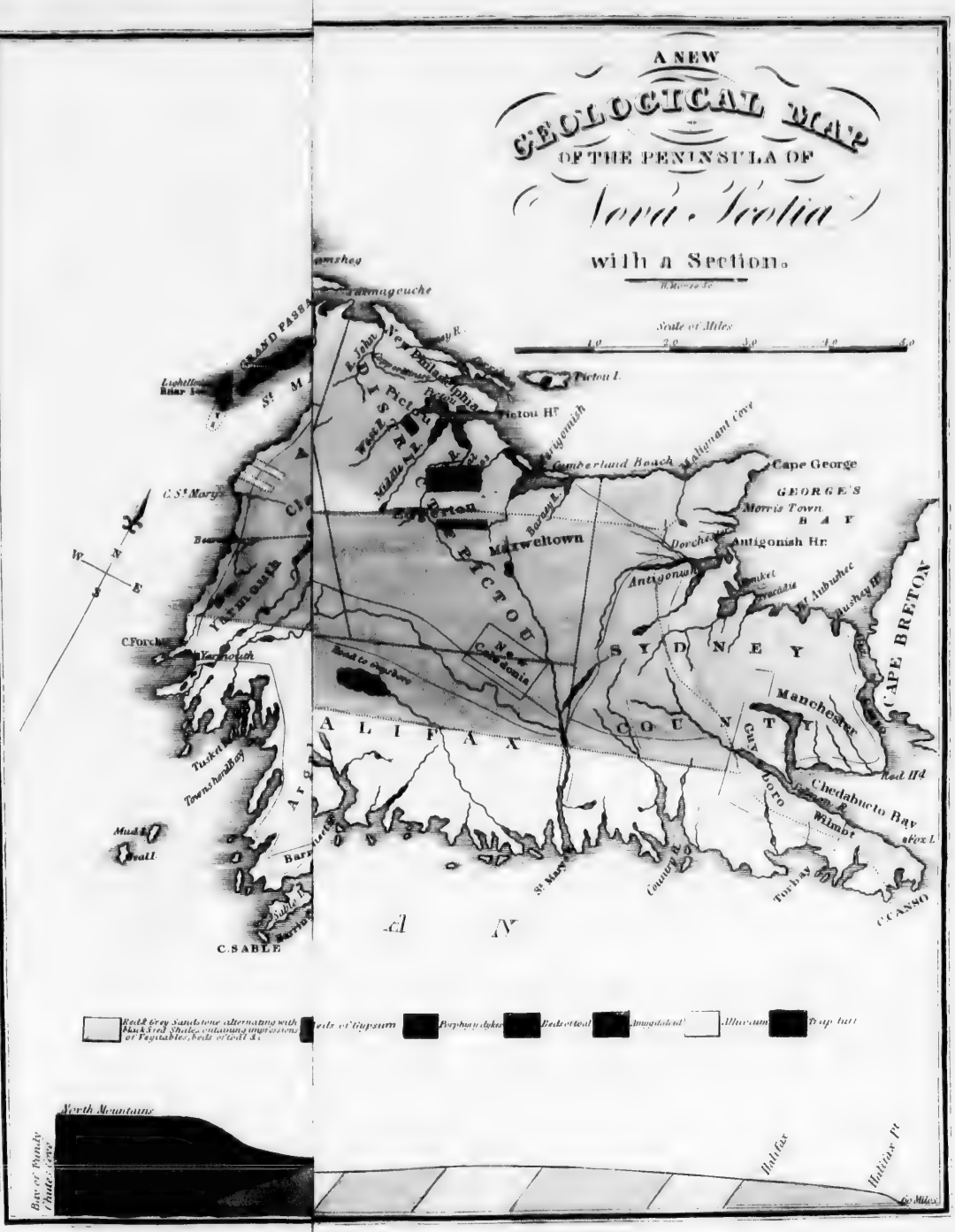
SPECIES.	SUBSPECIES.	VARIETIES.
Quartz.		
	common crystallized	
		limpid, smoky (Cairngorm).
		yellow, irised, radiated.
	Amethyst.	
		red and purple
	ferruginous	
	fetid	
	Chalcedony.	
		brown and green.
		Cacholong.
		Carnelian, Onyx.
		Agate, — ribbon, brecciated, fortification, and moss.
	Siliceous Sinter.	
		amethystine, and
		snow white.
	Heliotrope.	
	Opal.	
		Semi-opal.
	Hornstone.	
	Jasper.	
		common striped
		Agate-jasper.
		Ruin-jasper.
Siliceous Slate.		
		Basanite.
Mica.		
		laminated.
Schorl.		
		common black prismatic.
		acicular, in quartz.
Felspar.		
		common.
Garnet.		
	manganesian	
Stilbite.		
		yellow and white.
Laumonite		
Analcime		
		common, and red, or
		Sarcolite.
		cupreous green, a new variety.
Chabasie.		
		wine yellow.
		colorless.
Apophyllite.		
		green and white.
		Albin.
Heulandite.		
		red and white.
Thomsonite		
Mesotype.		
		Mesolite or Needlestone.
		Skolezite.
		plumous and filamentous.
Asbestus.		
		fibrous.
Hornblende.		

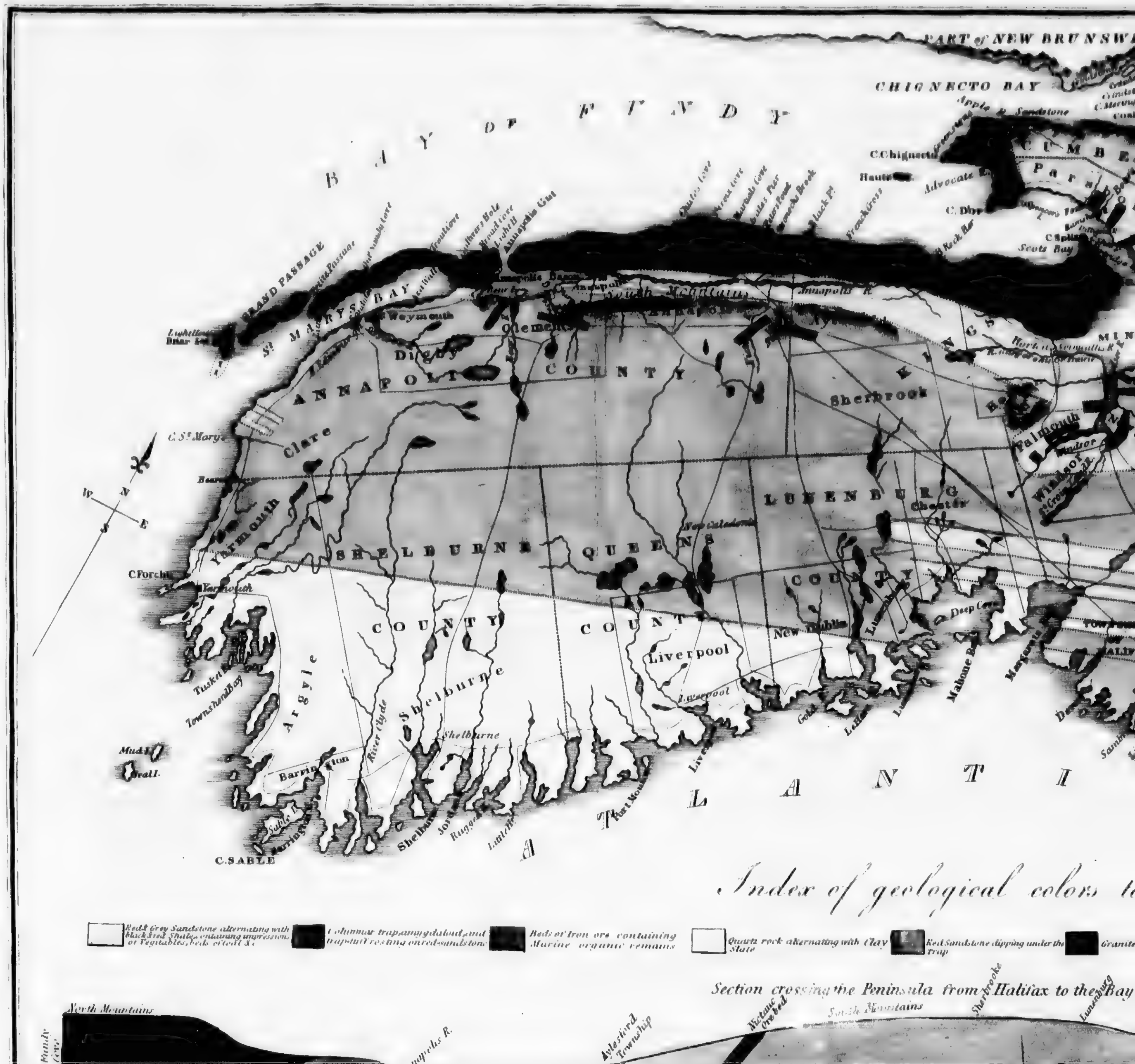
SPECIES.	SUBSPECIES.	VARIETIES.
Hornblende.		
	common	
Diallage.		massive.
	metalloidal	
Serpentine.		
Chlorite.		common.
		common, crystallized.
Argillaceous Slate.	Green Earth.	
		Argillite.
Graphite.		Roof Slate.
Coal.		granular.
Lignite.		common bituminous.
		Jet. Pitchy lignite.
		Bituminous wood.
Copper.		Brown, earthy, and brittle.
		native metallic.
		arborescent.
Sulphuret of Copper, or Vitreous Copper.		compact massive.
Pyritous Copper.		
Red Oxide of Copper.		common yellow.
Carbonate of Copper.		crystallized.
	blue	
		fibrous.
	green	
Sulphuret of Iron.		fibrous, (Malachite.)
		common amorphous.
		hepatic.
	arsenical	cubic.
Magnetic Oxide of Iron.		
		compact, granular, and crystallized.
Specular Oxide of Iron.		earthy.
	micaceous.	crystallized.
Red Oxide of Iron		
		compact.
		pseudomorphous.
Brown Oxide of Iron. (Hydrous oxide.)		Reddle.
		fascicular, in quartz and amethyst crystals.
		Brown Hematite.
		botryoidal and staalctitic.

SPECIES.	SUBSPECIES.	VARIETIES.
Argillaceus Oxide of Iron.		
		resinous granular.
		Shot ore. Bog ore.
Carbonate of Iron.		
		massive and crystallized.
Phosphate of Iron.		
		botryoidal and crystallized.
		earthy and pulverulent.
Sulphate of Iron.		
		efflorescent.
Sulphuret of Lead.		
		common.
	argentiferous	
Arseniate of Lead.		
		crystallized.
Oxide of Manganese, (Pyrolusite of Haidinger)		
	grey	
		radiated, compact, and acicular.
Chlorophæite.*		

* This rare and curious mineral is not yet established as a distinct species. It has been supposed by a late distinguished mineralogist, W. Phillips, to be allied to the Sideroclepte of Saussure ; but neither of these minerals has been analyzed.

A NEW GEOLOGICAL MAP OF THE PENINSULA OF Nova Scotia with a Section.





PART of NEW BRUNSWI
CHIGNECTO BAY
BAY OF FUNDY
C.Chignecto
Advocate
Scots Bay
GRAND PASSAGE
St MARYS BAY
Weymouth
Digby
Clements
Annapolis Basin
South Mountains
Annapolis R.
ANNAPOLIS COUNTY
Clare
C. St Marys
Sherbrook
KINGS
Falmouth
Windsor
LUNENBURG COUNTY
Chester
Yarmouth
C.Forchu
SHELBURNE COUNTY
QUEENS COUNTY
New Caledonia
Liverpool
New Dublin
Mahone B.
Deep Cove
Argyle
Tuskit
Townshend Bay
Mud I.
Seal I.
Barrington
River Clyde
Shelburne
C.SABLE
ATLANTIC
Index of geological colors to
Red & Grey Sandstone alternating with black & red Shale, containing impressions of Vegetables, beds of Coal &c.
Columnar trap, amygdaloid, and trap-tuff resting on red-sandstone
Beds of Iron ore containing Marine organic remains
Quartz rock alternating with Clay Slate
Red Sandstone dipping under the Trap
Granite
Section crossing the Peninsula from Halifax to the Bay
North Mountains
Bay of Fundy
Annapolis R.
Aylesford Township
South Mountains
Sherbrooke
Lunenburg

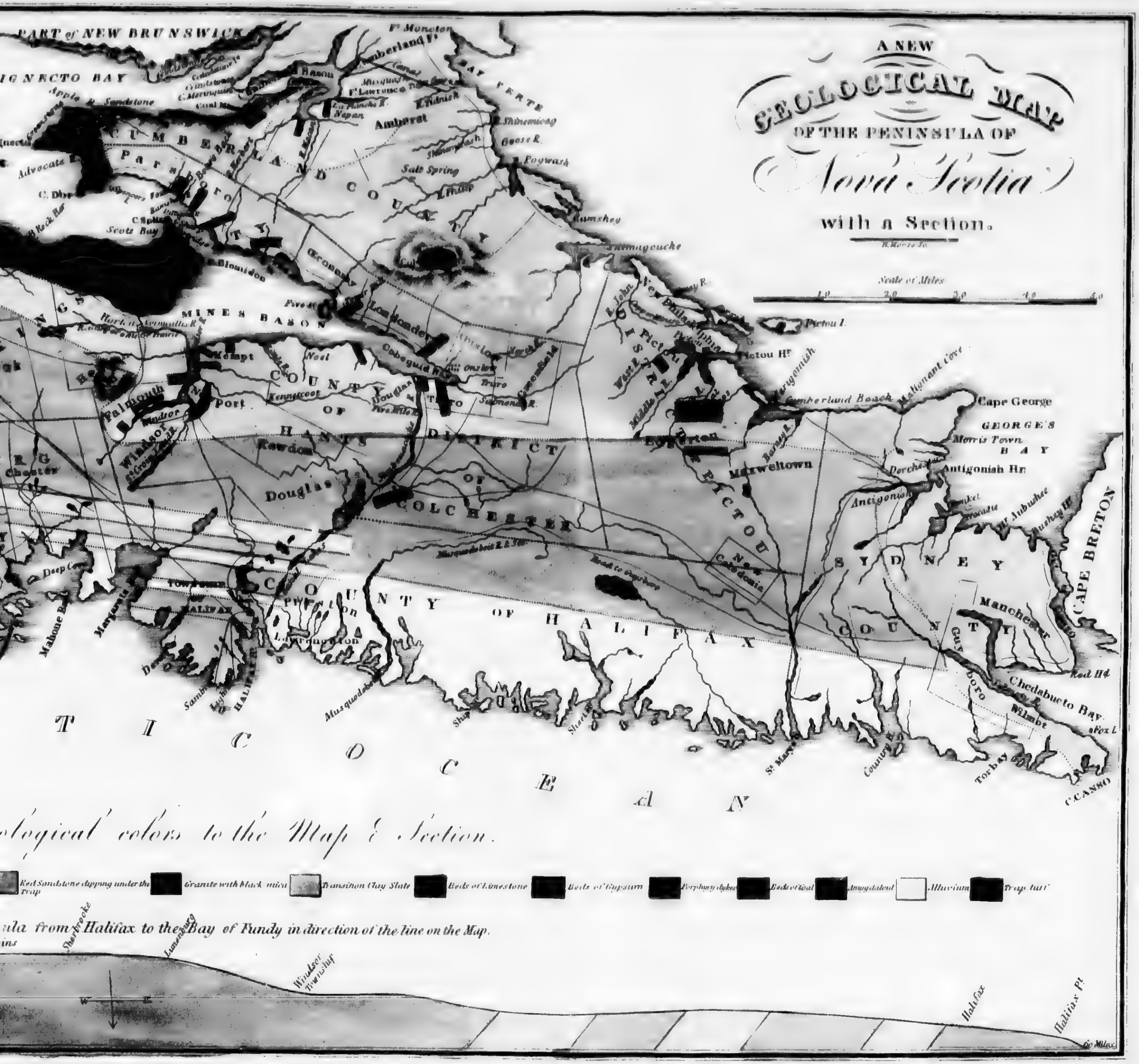
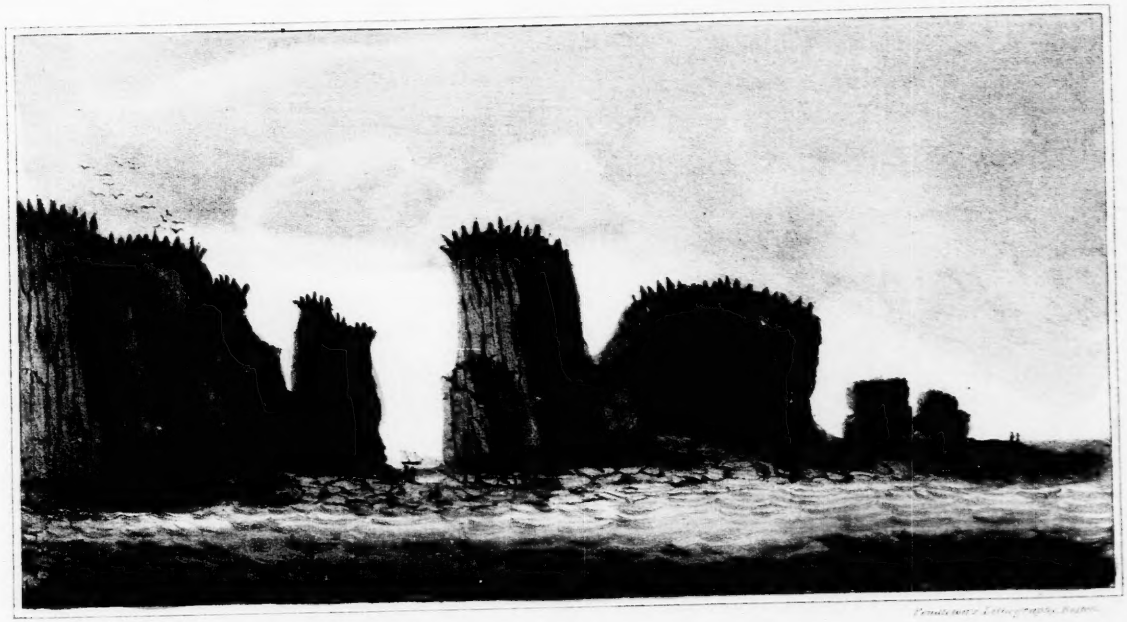

A NEW
GEOLOGICAL MAP
OF THE PENINSULA OF
Nova Scotia
with a Section.
Scale of Miles
10
20
30
40
50
PART of NEW BRUNSWICK
CHIGNECTO BAY
CUMBERLAND COUNTY
Amherst
BAY VERTE
Pugwash
Salt Spring
Tatmagouche
MINES BASON
Londonderry
Onslow
Truro
Cobequid
Windsor
Falmouth
Newport
Kempt
Noel
Douglas
Rawdon
COUNTY OF HANTS
DISTRICT OF COLCHESTER
DISTRICT OF PICTOU
Pictou I.
Pictou Hr.
Merigomish
Cape George
GEORGE'S BAY
Morris Town
Antigonish Hr.
Antigonish
SYDNEY COUNTY
Manchester
CAPE BRETON
Chedabucto Bay
Red Hd.
Fox I.
C. CANSO
Torbay
Country Hr.
St. Marys
Musquodoboit
Lawrencetown
COUNTY OF HALIFAX
Preston
Deep Cove
Malbone Bay
New Caledonia
Road to Guysboro
Merigomish
Advocate
Scots Bay
Blomidon
Horton
Five Mile R.
OCEAN
Geological colors to the Map & Section.
Red Sandstone dipping under the Trap
Granite with black mica
Transition Clay Slate
Beds of Limestone
Beds of Gypsum
Porphyry dykes
Beds of Coal
Amygdaloid
Alluvium
Trap tuff
from Halifax to the Bay of Fundy in direction of the line on the Map.
Sherbrooke
Lunenburg
Windsor Township
Halifax
Halifax Pt.

PLATE 12.



From a Sketch by C. T. Jackson

Printed at the Lithographic Press, Boston

VIEW OF THE DETACHED MASSES OF TRAP ROCK, AT THE SOUTH-WEST EXTREMITY OF PARTRIDGE ISLAND.

PLATE I

From a Sketch by C. T. Jackson. Pendleton's Lithography, Boston.

VIEW OF THE ISLANDS ON THE NORTHERN SHORE OF THE BASIN OF MINES.